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L. Agassiz

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LOUIS AGASSIZ

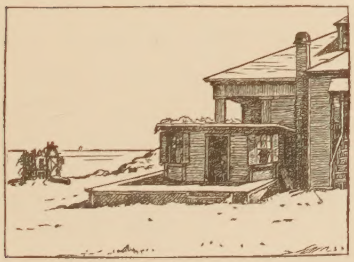
HIS LIFE AND CORRESPONDENCE

EDITED BY

ELIZABETH CARY AGASSIZ

IN TWO VOLUMES

VOL. II.



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LOUIS AGASSIZ:

HIS LIFE AND CORRESPONDENCE.

CHAPTER XIII.

1846 : ÆT. 39.

Arrival at Boston. — Previous Correspondence with Charles Lyell and Mr. John A. Lowell concerning Lectures at the Lowell Institute. — Relations with Mr. Lowell. — First Course of Lectures. — Character of Audience. — Home Letter giving an Account of his First Journey in the United States. — Impressions of Scientific Men, Scientific Institutions and Collections.

Agassiz arrived in Boston during the first week of October, 1846. He had not come to America without some prospect of employment beside that comprised in his immediate scientific aims. In 1845, when his plans for a journey in the United States began to take definite shape, he had written to ask Lyell whether, notwithstanding his imperfect English, he might not have some chance as a public lecturer, hoping to make in that way additional provision for his scientific expenses

beyond the allowance he was to receive from the King of Prussia. Lyell's answer, written by his wife, was very encouraging.

LONDON, *February* 28, 1845.

. . . My husband thinks your plan of lecturing a very good one, and sure to succeed, for the Americans are fond of that kind of instruction. We remember your English was pleasant, and if you have been practicing since, you have probably gained facility in expression, and a little foreign accent would be no drawback. You might give your lectures in several cities, but he would like very much if you could give a course at the Lowell Institute at Boston, an establishment which pays very highly. . . . In six weeks you might earn enough to pay for a twelve months' tour, besides passing an agreeable time at Boston, where there are several eminent naturalists. . . . As my husband is writing to Mr. Lowell to-morrow upon other matters, he will ask him whether there is any course still open, for he feels sure in that case they would be glad to have you. . . . Mr. Lowell is sole trustee of the Institute, and can nominate whom he pleases. It was very richly endowed for the purpose of lectures by a merchant of Bos-

ton, who died a few years ago. You will get nothing like the same remuneration anywhere else. . . .

Lyell and Mr. Lowell soon arranged all preliminaries, and it was understood that Agassiz should begin his tour in the United States by a course of lectures in Boston before the Lowell Institute. A month or two before sailing he writes as follows to Mr. Lowell.

PARIS, *July* 6, 1846.

. . . Time is pressing, summer is running away, and I feel it a duty to write to you about the contemplated lectures, that you may not be uncertain about them. So far as the subject is concerned, I am quite ready; all the necessary illustrations are also completed, and if I am not mistaken they must by this time be in your hands. . . . I understand from Mr. Lyell that you wish me to lecture in October. For this also I am quite prepared, as I shall, immediately after my arrival in Boston, devote all my time to the consideration of my course. If a later date should suit your plans better, I have no objection to conform to any of your arrangements, as I shall at all events pass the whole winter on the shores of

the Atlantic, and be everywhere in reach of Boston in a very short time. . . . With your approbation, I would give to my course the title of "Lectures on the Plan of the Creation, especially in the Animal Kingdom."

Thus was Agassiz introduced to the institution under whose auspices he first made acquaintance with his American audiences. There he became a familiar presence during more than a quarter of a century. The enthusiastic greeting accorded to him, as a stranger whose reputation had preceded him, ripened with years into an affectionate welcome from friends and fellow-citizens, whenever he appeared on the platform. In the director of the institution, Mr. John A. Lowell, he found a friend upon whose sympathy and wise counsels he relied in all his after years. The cordial reception he met from him and his large family circle made him at once at home in a strange land.

Never was Agassiz's power as a teacher, or the charm of his personal presence more evident than in his first course of Lowell Lectures. He was unfamiliar with the language, to the easy use of which his two or three visits in England, where most of his associates under-

stood and spoke French, had by no means accustomed him. He would often have been painfully embarrassed but for his own simplicity of character. Thinking only of his subject and never of himself, when a critical pause came, he patiently waited for the missing word, and rarely failed to find a phrase which was expressive if not technically correct. He often said afterward that his sole preparation for these lectures consisted in shutting himself up for hours and marshaling his vocabulary, passing in review, that is, all the English words he could recall. As the Lyells had prophesied, his foreign accent rather added a charm to his address, and the pauses in which he seemed to ask the forbearance of the audience, while he sought to translate his thought for them, enlisted their sympathy. Their courtesy never failed him. His skill in drawing with chalk on the blackboard was also a great help both to him and to them. When his English was at fault he could nevertheless explain his meaning by illustrations so graphic that the spoken word was hardly missed. He said of himself that he was no artist, and that his drawing was accurate simply because the object existed in his mind so clearly. However this may be,

it was always pleasant to watch the effect of his drawings on the audience. When showing, for instance, the correspondence of the articulate type, as a whole, with the metamorphoses of the higher insects, he would lead his listeners along the successive phases of insect development, talking as he drew and drawing as he talked, till suddenly the winged creature stood declared upon the blackboard, almost as if it had burst then and there from the chrysalis, and the growing interest of his hearers culminated in a burst of delighted applause.

After the first lecture in Boston there was no doubt of his success. He carried his audience captive. His treatment of the animal kingdom on the broad basis of the comparative method, in which the great types were shown in their relation to each other and to the physical history of the world, was new to his hearers. Agassiz had also the rare gift of divesting his subject of technicalities and superfluous details. His special facts never obscured the comprehensive outline, which they were intended to fill in and illustrate.

This simplicity of form and language was especially adapted to the audience he had now to address, little instructed in the facts or the

nomenclature of science, though characterized by an eager curiosity. A word respecting the quality of the Lowell Institute audience of those days, as new to the European professor as he to them, is in place here. The institution was intended by its founder to fertilize the general mind rather than to instruct the selected few. It was liberally endowed, the entrance was free, and the tickets were drawn by lot. Consequently the working men and women had as good an opportunity for places as their employers. As the remuneration, however, was generous, and the privilege of lecturing there was coveted by literary and scientific men of the first eminence, the instruction was of a high order, and the tickets, not to be had for money, were as much in demand with the more cultivated and even with the fashionable people of the community as with their poorer neighbors. This audience, composed of strongly contrasted elements and based upon purely democratic principles, had, from the first, a marked attraction for Agassiz. A teacher in the widest sense, he sought and found his pupils in every class. But in America for the first time did he come into contact with the general mass of the people on this common ground, and it influenced strongly

his final resolve to remain in this country. Indeed, the secret of his greatest power was to be found in the sympathetic, human side of his character. Out of his broad humanity grew the genial personal influence, by which he awakened the enthusiasm of his audiences for unwonted themes, inspired his students to disinterested services like his own, delighted children in the school-room, and won the cordial interest as well as the coöperation in the higher aims of science, of all classes whether rich or poor.

His first course was to be given in December. Having, therefore, a few weeks to spare, he made a short journey, stopping at New Haven to see the elder Silliman, with whom he had long been in correspondence. Shortly before leaving Europe he had written him, "I can hardly tell you with what pleasure I look forward to seeing you, and making the personal acquaintance of the distinguished savans of your country, whose works I have lately been studying with especial care. There is something captivating in the prodigious activity of the Americans, and the thought of contact with the superior men of your young and glorious republic renews my own youth." Some account of this journey, including his

first impressions of the scientific men as well as the scientific societies and collections of the United States, is given in the following letter. It is addressed to his mother, and with her to a social club of intimate friends and neighbors in Neuchâtel, at whose meetings he had been for years an honored guest.

BOSTON, *December*, 1846.

. . . Having no time to write out a complete account of my journey of last month, I will only transcribe for you some fugitive notes scribbled along the road in stages or railroad carriages. They bear the stamp of hurry and constant interruption.

Leaving Boston the 16th of October, I went by railroad to New Haven, passing through Springfield. The rapidity of the locomotion is frightful to those who are unused to it, but you adapt yourself to the speed, and soon become, like all the rest of the world, impatient of the slightest delay. I well understand that an antipathy for this mode of travel is possible. There is something infernal in the irresistible power of steam, carrying such heavy masses along with the swiftness of lightning. The habits growing out of continued contact with railroads,

and the influence they exert on a portion of the community, are far from agreeable until one is familiar with them. You would cry out in dismay did you see your baggage flung about pell-mell like logs of wood, trunks, chests, traveling-bags, hat-boxes, all in the same mill, and if here and there something goes to pieces no one is astonished; never mind! we go fast, — we gain time, — that is the essential thing.

The manners of the country differ so greatly from ours that it seems to me impossible to form a just estimate regarding them, or, indeed, to pronounce judgment at all upon a population so active and mobile as that of the Northern States of the Union, without having lived among them for a long time. I do not therefore attempt any such estimate. I can only say that the educated Americans are very accessible and very pleasant. They are obliging to the utmost degree; indeed, their cordiality toward strangers exceeds any that I have met elsewhere. I might even add that if I could complain of anything it would be of an excess, rather than a lack, of attention. I have often found it difficult to make it understood that the hotel, where I can work at my ease, suits me better than the proffered hospitality. . . .

But what a country is this! all along the road between Boston and Springfield are ancient moraines and polished rocks. No one who had seen them upon the track of our present glaciers could hesitate as to the real agency by which all these erratic masses, literally covering the country, have been transported. I have had the pleasure of converting already several of the most distinguished American geologists to my way of thinking; among others, Professor Rogers, who will deliver a public lecture upon the subject next Tuesday before a large audience.

A characteristic feature of American life is to be found in the frequent public meetings where addresses are delivered. Shortly after my arrival in Boston I was present at a meeting of some three thousand workmen, foremen of workshops, clerks, and the like. No meeting could have been more respectable and well-conducted. All were neatly dressed; even the simplest laborer had a clean shirt. It was a strange sight to see such an assemblage, brought together for the purpose of forming a library, and listening attentively in perfect quiet for two hours to an address on the advantages of education, of reading, and the means of employing usefully the leisure mo-

ments of a workman's life. The most eminent men vie with each other in instructing and forming the education of the population at large. I have not yet seen a man out of employment or a beggar, except in New York, which is a sink for the emptyings of Europe. Yet do not think that I forget the advantages of our old civilization. Far from it. I feel more than ever the value of a past which belongs to you and in which you have grown up. Generations must pass before America will have the collections of art and science which adorn our cities, or the establishments for public instruction, sanctuaries as it were, consecrated by the devotion of those who give themselves wholly to study. Here all the world works to gain a livelihood or to make a fortune. Few establishments (of learning) are old enough, or have taken sufficiently deep root in the habits of the people, to be safe from innovation; very few institutions offer a combination of studies such as, in its ensemble, meets the demands of modern civilization. All is done by the single efforts of individuals or of corporations, too often guided by the needs of the moment. Thus American science lacks the scope which is characteristic of higher instruction in our old Europe. Objects

of art are curiosities but little appreciated and usually still less understood. On the other hand, the whole population shares in the advanced education provided for all. . . . From Springfield the railroad follows the course of the Connecticut as far as Hartford, turning then directly toward the sea-coast. The valley strikingly resembles that of the Rhine between Carlsruhe and Heidelberg. The same rock, the same aspect of country, and grès bigarré[1] everywhere. The forest reminds one of Odenwald and of Baden-Baden. Nearer the coast are cones of basalt like those of Brissac and the Kaiserstuhl. The erratic phenomena are also very marked in this region; polished rocks everywhere, magnificent furrows on the sandstone and on the basalt, and parallel moraines defining themselves like ramparts upon the plain.

At New Haven I passed several days at the house of Professor Silliman, with whom I have been in correspondence for several years. The University (Yale) owes to the efforts of the Professor a fine collection of minerals and extensive physical and chemical apparatus. Silliman is the patriarch of science in America. For thirty years he has edited

[1] Trias.

an important scientific journal, the channel through which, ever since its foundation, European scientific researches have reached America. His son is now professor of chemistry at Yale. One of his sons-in-law, Mr. Shepard, is also chemical professor in the University of South Carolina. Another, Mr. Dana, still a very young man, strikes me as likely to be the most distinguished naturalist of the United States. He was a member of the expedition around the world under the command of Captain Wilkes, and has just published a magnificent volume containing monographs of all the species of polyps and corals, with curious observations on their mode of growth and on the coral islands. I was surprised to find in the collection at New Haven a fine specimen of the great fossil salamander of Oeningen, the "Homo diluvii testis" of Scheuchzer.

From New Haven I went to New York by steamboat. The Sound, between Long Island and the coast of Connecticut, presents a succession of cheerful towns and villages, with single houses scattered over the country, while magnificent trees overhang the sea; we constantly disturbed numbers of aquatic birds which, at our approach, fluttered up around

the steamer, only to alight farther on. I have never seen such flocks of ducks and gulls.

At New York I hastened to see Auguste Mayor, of whom my uncle will no doubt have given you news, since I wrote to him. Obliged to continue my road in order to join Mr. Gray at Princeton I stopped but one day in New York, the greater part of which I passed with Mr. Redfield, author of a paper on the fossil fishes of Connecticut. His collection, which he has placed at my disposal, has great interest for me; it contains a large number of fossil fishes of different kinds, from a formation in which but one species has been found in Europe. The new red sandstone of Connecticut will also fill a gap in the history of fossil fishes, and this acquisition is so much the more important, because, at the epoch of the grès bigarré, a marked change took place in the anatomical character of fishes. It presents an intermediate type between the primitive fishes of the ancient deposits and the more regular forms of the jurassic deposits.

Mr. Asa Gray, professor of botany at Cambridge, near Boston, had offered to accompany me on my journey to Washington. We were to meet at the house of Professor Tor-

rey, at Princeton, a small town half a day's journey from New York, and the seat of a considerable university, one of the oldest in the United States. The physical department, under the direction of Professor Henry, is remarkably rich in models of machinery and in electrical apparatus, to which the professor especially devotes himself. The museum contains a collection of animals and fossil remains. In the environs of the town, in the ditches, is found a rare kind of turtle, remarkable for the form of the jaws and the length of the tail. I wish very much to procure one, were it only to oblige Professor Johannes Müller, of Berlin, who especially desires one for investigation. But I have failed thus far; the turtles are already withdrawn into their winter quarters. Mr. Torrey promises me some, however, in the spring. It is not easy to get them because their bite is dreaded.

After this I passed four days in Philadelphia. Here, notwithstanding my great desire to see the beautiful country along the shores of the rich bay of Delaware and the banks of the Schuylkill, between which the city lies, I was entirely occupied with the magnificent collections of the Academy of Science and

of the Philosophical Society. The zoölogical collections of the Academy of Science are the oldest in the United States, the only ones, except those of the Wilkes Expedition, which can equal in interest those of Europe. There are the collections of Say, the earliest naturalist of distinction in the United States; there are also the fossil remains and the animals described by Harlan, by Godman, and by Hayes, and the fossils described by Conrad and Morton. Dr. Morton's unique collection of human skulls is also to be found in Philadelphia. Imagine a series of six hundred skulls, mostly Indian, of all the tribes who now inhabit or formerly inhabited America. Nothing like it exists elsewhere. This collection alone is worth a journey to America. Dr. Morton has had the kindness to give me a copy of his great illustrated work representing all the types of his collection. Quite recently a generous citizen of Philadelphia has enriched this museum with the fine collection of birds belonging to the Duke of Rivoli. He bought it for 3,700 francs, and presented it to his native city.

The number of fossil remains comprised in these collections is very considerable; mastodons especially, and fossils of the cretaceous

and jurassic deposits. . . . Imagine that all this is at my full disposal for description and illustration, and you will understand my pleasure. The liberality of the American naturalists toward me is unparalleled.

I must not omit to mention Mr. Lea's collection of fresh-water shells, — a series of the magnificent Unios of the rivers and lakes of America, comprising four hundred species, represented by some thirty specimens of each. Mr. Lea has promised me specimens of all the species. Had I not been bound by an engagement at Washington, and could I have remained three or four days longer in order to label and pack them, I might have taken at once these valuable objects, which will be of great importance in verifying and rectifying the synonyms of European conchologists. After having seen the astonishing variations undergone by these shells in their growth, I am satisfied that all which European naturalists have written on this subject must be revised. Only with the help of a very full series of individuals can one fully understand these animals, and we have only single specimens in our collections. If I had time and means to have drawings made of all these forms, the collection of Mr. Lea would be at

my command for the purpose, and the work would be a very useful one for science.

There are several other private and public collections at Philadelphia, which I have only seen cursorily; that of the Medical School, for instance, and that of the older Peale, who discovered the first mastodon found in the United States, now mounted in his museum. Beside these, there is the collection of Dr. Griffith, rich in skulls from the Gulf of Mexico; that of Mr. Ord, and others. During my stay in Philadelphia, there was also an exhibition of industrial products at the Franklin Institute, where I especially remarked the chemical department. There are no less than three professors of chemistry in Philadelphia, — Mr. Hare, Mr. Booth, and Mr. Frazer. The first is, I think, the best known in Europe.

How a nearer view changes the aspect of things! I thought myself tolerably familiar with all that is doing in science in the United States, but I was far from anticipating so much that is interesting and important. What is wanting to all these men is neither zeal nor knowledge. In both, they seem to compete with us, and in ardor and activity they even surpass most of our savans. What they need

is leisure. I have never felt more forcibly what I owe to the king for enabling me to live for science alone, undisturbed by anxieties and distractions. Here, I do not lose a moment, and when I receive invitations outside the circle of men whom I care particularly to know, I decline, on the ground that I am not free to dispose for my pleasure of time which does not belong to me. For this no one can quarrel with me, and so far as I myself am concerned, it is much better.

I stopped at Baltimore only long enough to see the city. It was Sunday, and as I could make no visits, and was anxious to arrive in good time at Washington, I took advantage of the first train. The capital of the United States is laid out upon a gigantic scale, and, consequently, portions of the different quarters are often to be traced only by isolated houses here and there, — a condition which has caused it to be called the "City of Magnificent Distances." Some of the streets are very handsome, and the capitol itself is really imposing. Their profound veneration for the founder of their liberty and their republic is a noble trait of the American people. The evidences of this are to be seen everywhere. No less than two hundred towns, villages, and

counties bear his name, rather to the inconvenience of the postal administration.

After having visited the capitol and the presidential mansion, and delivered my letters for the Prussian Minister, I went to the Museum of the National Institute. I was impatient to satisfy myself as to the scientific value of the results obtained in the field of my own studies by the voyage of Captain Wilkes around the world, — this voyage having been the object of equally exaggerated praise and criticism. I confess that I was agreeably surprised by the richness of the zoölogical and geological collections; I do not think any European expedition has done more or better; and in some departments, in that of the Crustacea, for example, the collection at Washington surpasses in beauty and number of specimens all that I have seen. It is especially to Dr. Pickering and Mr. Dana that these collections are due. As the expedition did not penetrate to the interior of the continents in tropical regions, the collections of birds and mammals, which fell to the charge of Mr. Peale, are less considerable. Mr. Gray tells me, however, that the botanical collections are very large. More precious, perhaps, than all the collections are the magnificent drawings

of mollusks, zoöphytes, fishes, and reptiles, painted from life by Mr. Drayton. All these plates, to the number of about six hundred, are to be engraved, and indeed are already, in part, executed. I can only compare them to those of the Astrolabe, although they are very superior in variety of position and naturalness of attitude to those of the French Expedition. This is particularly true of the mollusks and fishes. The zoöphytes are to be published; they are admirable in detail. The hydrographic portion and the account of the voyage, edited by Captain Wilkes (unhappily he was absent and I did not see him), has been published for some time, and comprises an enormous mass of information, its chief feature being charts to the number of two hundred. It is amazing; the number of soundings extraordinarily large.[1]

At Washington are also to be seen the headquarters of the Coast Survey, where the fine charts of the coasts and harbors now making under direction of Dr. Bache are executed. These charts are admirably finished. Dr. Bache, the superintendent, was in camp, so

[1] Agassiz subsequently took some part in working up the fish collections from this expedition, but the publication was stopped for want of means to carry it on.

that I could not deliver my letters for him. I saw, however, Colonel Abert, the head of the topographic office, who gave me important information about the West for the very season when I am likely to be there. I am indebted to him also for a series of documents concerning the upper Missouri and Mississippi, California and Oregon, printed by order of the government, and for a collection of fresh-water shells from those regions. I should like to offer him, in return, such sheets of the Federal Map as have appeared. I beg Guyot to send them to me by the first occasion.

As I was due in Boston on an appointed day I was obliged to defer my visit to Richmond, Charleston, and other places in the South. I had, beside, gathered so much material that I had need of a few quiet weeks to consider and digest it all. Returning therefore to Philadelphia, I made there the acquaintance of Mr. Haldeman, author of a monograph on the fresh-water shells of the United States. I had made an appointment to meet him at Philadelphia, being unable to make a detour of fifty leagues in order to visit him at his own home, which is situated beyond the lines of rapid transit. He is a distinguished naturalist, equally well versed in

several branches of our science. He has made me acquainted, also, with a young naturalist from the interior of Pennsylvania, Mr. Baird, professor at Dickinson College, in Carlisle, Pennsylvania, who offered me duplicates from his collections of birds and other animals. In order to avail myself more promptly of this and like acquisitions, I wish that M. Coulon would send me at the close of the winter all that he can procure of the common European birds, of our small mammalia, and some chamois skins, adding also the fish that Charles put aside for me before his departure. It would be safest to send them to the care of Auguste Mayor.

At Philadelphia I separated from my traveling companion, Mr. Gray, who was obliged to return to his home. From Philadelphia, Mr. Haldeman and Mr. Lea accompanied me to Bristol, where Mr. Vanuxem possesses an important collection of fossils from ancient deposits, duplicates of which he promises me. Mr. Vanuxem is one of the official geologists of the State of New York, and author of one of a series of volumes upon the geology of the State, about which I shall presently have something to say. To gain time I took the night train from Bristol to New York, and

arrived at Mayor's at midnight, having written him to expect me.

The next day I visited the market, and in five days I had filled a great barrel with different kinds of fish and fresh-water turtles, beside making several skeletons and various dissections of mollusks. Wishing to employ my time as usefully as possible, I postponed my visits to the savans of the city, and the delivery of my letters, till I was on the eve of departure, that I might avoid all invitations. I had especial pleasure in making the acquaintance of the two Le Contes, father and son, who own the finest collection of insects in the United States. I can easily make some thousand exchanges with them when I receive those that M. Coulon has put aside for me, with a view to exchange. . . . Every morning Auguste Mayor went with me to the market before going to his office and helped me to carry my basket when it was too heavy. One day I brought back no less than twenty-four turtles, taken in one draught of the net. I made four skeletons, and dissected several others. Under such conditions the day ought to have thirty-six working hours.

Were I an artist, instead of describing my voyage from New York to Albany, I would

draw you a panorama of the shores of the Hudson. I know nothing except the banks of the Rhine to compare with those of this magnificent river. The resemblance between them is striking; the sites, the nature of the rocks, the appearance of the towns and villages, the form of the Albany bridges, even the look of the inhabitants, of whom the greater number are of Dutch or German origin, — all are similar.

I stopped at West Point to make the acquaintance of Professor Bailey of the Military School there. I already knew him by reputation. He is the author of very detailed and interesting researches upon the microscopic animalcules of America. I had a pamphlet to deliver to him from Ehrenberg, who has received from him a great deal of material for his large work on fossil Infusoria. I spent three most delightful days with him, passed chiefly in examining his collections, from which he gave me many specimens. We also made several excursions in the neighborhood, in order to study the erratic phenomena and the traces of glaciers, which everywhere cover the surface of the country. Polished rocks, as distinct as possible; moraines continuous over large spaces; stratified drift, as on

the borders of the glacier of Grindelwald; in short, all the usual accompaniments of the glaciers are there, and one may follow the "roches moutonnées" with the eye to a great distance.

Albany is the seat of government of the State of New York. It has a medical school, an agricultural society, a geological museum, an anatomical museum, and a museum of natural history. The government has just completed the publication of a work, unique of its kind, a natural history of the State in sixteen volumes, quarto, with plates; twenty-five hundred copies have been printed, only five hundred of which are for sale, the rest being distributed throughout the State. Four volumes are devoted to geology and mining alone, the others to zoölogy, botany, and agriculture. Yes, twenty-five hundred copies of a work in sixteen volumes, quarto, scattered throughout the State of New York alone! When I think that I began my studies in natural history by copying hundreds of pages from a Lamarck which some one had lent me, and that to-day there is a State in which the smallest farmer may have access to a costly work, worth a library to him in itself, I bless the efforts of those who devote themselves to public instruc-

tion. . . . I have not neglected the opportunity offered by the North River (the Hudson) for the study of the fresh-water fishes of this country. I have filled a barrel with them. The species differ greatly from ours, with the exception of the perch, the eel, the pike, and the sucker, in which only a practiced eye could detect the difference; all the rest belong to genera unknown in Europe, or, at least, in Switzerland. . . .

I was fortunate enough to procure also, in the few days of my stay, all the species taken in the lakes and rivers around Albany. Several others have been given me from Lake Superior. Since my return to Boston I have been collecting birds and comparing them with those of Europe. If M. Coulon could obtain for me a collection of European eggs, even the most common, I could exchange them for an admirable series of the native species here. I have also procured several interesting mammals; among others, two species of hares different from those I brought from Halifax, striped squirrels, etc.

I will tell you another time something of the collections of Boston and Cambridge, the only ones in the United States which can rival those of Philadelphia. To-day I have made

my first attempt at lecturing. Of that, also, I will tell you more in my next letter, when I know how it has been liked. It is no small matter to satisfy an audience of three thousand people in a language with which you are but little familiar. . . .

CHAPTER XIV.

1846–1847: ÆT. 39–40.

Course of Lectures in Boston on Glaciers. — Correspondence with Scientific Friends in Europe. — House in East Boston. — Household and Housekeeping. — Illness. — Letter to Élie de Beaumont. — Geology and Glacial Remains.

THE course at the Lowell Institute was immediately followed by one upon glaciers, the success of which was guaranteed by private subscription, — an unnecessary security, since the audience, attracted by the novelty and picturesqueness of the subject, as well as by the charm of presentation and fullness of illustration, was large and enthusiastic.

Agassiz was evidently encouraged himself by his success, for toward the close of his Lowell Lectures he writes as follows: —

TO CHANCELLOR FAVARGEZ.

BOSTON, *December* 31, 1846.

. . . Beside my lecture course, now within a few days of its conclusion, and the ever-increasing work which grows on my hands in

proportion as I become familiar with the environs of Boston, where I shall still remain a few weeks longer, I have so much to do in keeping up my journals, notes, and observations that I have not found a moment to write you since the last steamer. . . . Never did the future look brighter to me than now. If I could for a moment forget that I have a scientific mission to fulfill, to which I will never prove recreant, I could easily make more than enough by lectures which would be admirably paid and are urged upon me, to put me completely at my ease hereafter. But I will limit myself to what I need in order to repay those who have helped me through a difficult crisis, and that I can do without even turning aside from my researches. Beyond that all must go again to science, — there lies my true mission. I rejoice in what I have been able to do thus far, and I hope that at Berlin they will be satisfied with the results which I shall submit to competent judges on my return. If I only have time to finish what I have begun! You know my plans are not wont to be too closely restricted.

Why do you not write to me? Am I then wholly forgotten in your pleasant circle while my thoughts are every day constantly with my Neuchâtel friends? . . .

Midnight, January 1st. A happy new year to you and to all members of the Tuesday Club. Bonjour et bon an. . . .

Some portions of Agassiz's correspondence with his European friends and colleagues during the winter and summer of 1847 give a clew to the occupations and interests of his new life, and keep up the thread of the old one.

LOUIS AGASSIZ TO M. DECAISNE.

February, 1847.

. . . I write only to thank you for the pleasure your note gave me. When one is far away, as I am, from everything belonging to one's past life, the merest sign of friendly remembrance is a boon. Do not infer from this that America does not please me. On the contrary, I am delighted with my stay here, although I do not quite understand all that surrounds me; or I should perhaps rather say that many principles which, theoretically, we have been wont to think perfect in themselves, seem in their application to involve results quite contrary to our expectations. I am constantly asking myself which is better, — our old Europe, where the man of exceptional gifts can give himself absolutely

to study, opening thus a wider horizon for the human mind, while at his side thousands barely vegetate in degradation or at least in destitution; or this new world, where the institutions tend to keep all on one level as part of the general mass, — but a mass, be it said, which has no noxious elements. Yes, the mass here is decidedly good. All the world lives well, is decently clad, learns something, is awake and interested. Instruction does not, as in some parts of Germany for instance, furnish a man with an intellectual tool and then deny him the free use of it. The strength of America lies in the prodigious number of individuals who think and work at the same time. It is a severe test of pretentious mediocrity, but I fear it may also efface originality. . . . You are right in believing that one works, or at least that one *can* work, better in Paris than elsewhere, and I should esteem myself happy if I had my nest there, but who will make it for me? I am myself incapable of making efforts for anything but my work. . . .

AGASSIZ TO MILNE EDWARDS.

May 31, 1847.

. . . After six weeks of an illness which has rendered me unfit for serious work I long to be transported into the circle of my Paris friends, to find myself again among the men whose devotion to science gives them a clear understanding of its tendency and influence. Therefore I take my way quite naturally to the Rue Cuvier and mount your stairs, confident that there I shall find this chosen society. Question upon question greets me regarding this new world, on the shore of which I have but just landed, and yet about which I have so much to say that I fear to tire my listeners.

Naturalist as I am, I cannot but put the people first, — the people who have opened this part of the American continent to European civilization. What a people! But to understand them you must live among them. Our education, the principles of our society, the motives of our actions, differ so greatly from what I see here, that I should try in vain to give you an idea of this great nation, passing from childhood to maturity with the faults of spoiled children, and yet with the

nobility of character and the enthusiasm of youth. Their look is wholly turned toward the future; their social life is not yet irrevocably bound to exacting antecedents, and thus nothing holds them back, unless, perhaps, a consideration for the opinion in which they may be held in Europe. This deference toward England (unhappily, to them, Europe means almost exclusively England) is a curious fact in the life of the American people. They know us but little, even after having made a tour in France, or Italy, or Germany. From England they receive their literature, and the scientific work of central Europe reaches them through English channels. . . . Notwithstanding this kind of dependence upon England, in which American savans have voluntarily placed themselves, I have formed a high opinion of their acquirements, since I have learned to know them better, and I think we should render a real service to them and to science, by freeing them from this tutelage, raising them in their own eyes, and drawing them also a little more toward ourselves. Do not think that these remarks are prompted by the least antagonism toward English savans, whom no one more than myself has reason to regard with affection and esteem. But since

these men are so worthy to soar on their own wings, why not help them to take flight? They need only confidence, and some special recognition from Europe would tend to give them this. . . .

Among the zoölogists of this country I would place Mr. Dana at the head. He is still very young, fertile in ideas, rich in facts, equally able as geologist and mineralogist. When his work on corals is completed, you can better judge of him. One of these days you will make him a correspondent of the Institute, unless he kills himself with work too early, or is led away by his tendency to generalization. Then there is Gould, author of the malacologic fauna of Massachusetts, and who is now working up the mollusks of the Wilkes Expedition. De Kay and Lea, whose works have long been known, are rather specialists, I should say. I do not yet know Holbrook personally. Pickering, of the Wilkes Expedition, is a well of science, perhaps the most erudite naturalist here. Haldeman knows the fresh-water gasteropods of this country admirably well, and has published a work upon them. Le Conte is a critical entomologist who seems to me thoroughly familiar with what is doing in Europe. In connection with Halde-

man he is working up the articulates of the Wilkes Expedition. Wyman, recently made professor at Cambridge, is an excellent comparative anatomist, and the author of several papers on the organization of fishes. . . . The botanists are less numerous, but Asa Gray and Dr. Torrey are known wherever the study of botany is pursued. Gray, with his indefatigable zeal, will gain upon his competitors. . . . The geologists and mineralogists form the most numerous class among the savans of the country. The fact that every state has its corps of official geologists has tended to develop study in this direction to the detriment of other branches, and will later, I fear, tend to the detriment of science itself; for the utilitarian tendency thus impressed on the work of American geologists will retard their progress. With us, on the contrary, researches of this kind constantly tend to assume a more and more scientific character. Still, the body of American geologists forms, as a whole, a most respectable contingent. The names of Charles T. Jackson, James Hall, Hitchcock, Henry and William Rogers (two brothers), have long been familiar to European science. After the geologists, I would mention Dr. Morton, of Philadelphia, well known as the author of sev-

eral papers upon fossils, and still better by his great work upon the indigenous races of America. He is a man of science in the best sense; admirable both as regards his knowledge and his activity. He is the pillar of the Philadelphia Academy.

The chemists and physicists, again, form another utilitarian class of men in this country. As with many of them purely scientific work is not their sole object, it is difficult for an outsider to distinguish between the clever manipulators and those who have higher aims. . . .

The mathematicians have also their *culte*, dating back to Bowditch, the translator of the "Mécanique céleste," and the author of a work on practical navigation. He died in Boston, where they are now erecting a magnificent monument to his memory. Mr. Peirce, professor at Cambridge, is considered here the equal of our great mathematicians. It is not for me, who cannot do a sum in addition, to pretend to a judgment in the matter.[1]

You are familiar, no doubt, with the works of Captain Wilkes and the report of his jour-

[1] Though Agassiz was no mathematician, and Peirce no naturalist, they soon found that their intellectual aims were the same, and they became very close friends.

ney around the world. His charts are much praised. The charts of the coasts and harbors of the United States, made under the direction of Dr. Bache and published at government expense, are admirable. The reports of Captain Frémont concerning his travels are also most interesting and instructive; to botanists especially so, on account of the scientific notes accompanying them.

I will not speak at length of my own work, — my letter is already too long. During the winter I have been chiefly occupied in making collections of fishes and birds, and also of the various woods. The forests here differ greatly from ours in the same latitude. I have even observed that they resemble astonishingly the forests of the Molasse epoch, and the analogy is heightened by that between the animals of this country and those of the eastern coasts of Asia as compared with those of the Molasse, such as the chelydras, andreas, etc. I will send a report upon this to M. Brongniart as soon as I have the time to prepare it. On the erratic phenomena, also, I have made numerous observations, which I am anxious to send to M. de Beaumont. These phenomena, so difficult of explanation with us, become still more complicated here,

both on account of their contact with the sea and of the vast stretches of flat country over which they extend.

For the last few days I have been especially occupied with the development of the medusæ. In studying the actiniæ I have made a striking discovery, and I should be glad if you would communicate it to the Academy in advance of the illustrated paper on the same subject, which I hope soon to send you. Notwithstanding their star-like appearance, the star-fishes have, like the sea-urchins, indications by no means doubtful, of a symmetrical disposition of their organs in pairs, and an anterior and posterior extremity easily recognized by the special form of their oral opening. I have now satisfied myself that the madrepores have something analogous to this in the arrangement of their partitions, so that I am tempted to believe that this tendency to a symmetrical arrangement of parts in pairs, is a general character of polyps, disguised by their radiating form. Among the medusæ something similar exists in the disposition of the marginal appendages and the ocelli. I attach the more importance to these observations, because they may lead to a clearer perception than we have yet reached

of the natural relations between the radiates and the other great types of the animal kingdom.

This summer I hope to explore the lower lakes of Canada, and also the regions lying to the eastward as far as Nova Scotia; in the autumn I shall resume my excursions on the coast and in the Alleghanies, and shall pass a part of the winter in the Carolinas. I will soon write to Monsieur Brongniart concerning my plans for next year. If the Museum were desirous to aid me in my undertakings, I should like to make a journey of exploration next summer in a zone thus far completely neglected by naturalists, the region, namely, of the small lakes to the west of Lake Superior, where the Mississippi takes its rise, and also of that lying between this great basin of fresh water and the southern arm of Hudson Bay. I would employ the autumn in exploring the great valley of the Mississippi, and would pass the winter on the borders of the Gulf of Mexico.

To carry out such projects, however, I have need of larger resources than I can create by my own efforts, and I shall soon be at the end of the subsidy granted me by the King of Prussia. I shall, however, subordinate all

these projects to the possibilities of which you kindly tell me. Notwithstanding the interest offered by the exploration of a country so rich as this, notwithstanding the gratifying welcome I have received here, I feel, after all, that nowhere can one work better than in our old Europe, and the friendship you have shown me is a more than sufficient motive, impelling me to return as soon as possible to Paris. Remember me to our common friends. I have made some sufficiently interesting collections which I shall forward to the Museum; they will show you that I have done my best to fulfill my promises, forgetting no one. . . .

In the summer of 1847 Agassiz established himself in a small house at East Boston, sufficiently near the sea to be a convenient station for marine collections. Here certain members of his old working corps assembled about him, and it soon became, like every place he had ever inhabited, a hive of industry. Chief among his companions were Count François de Pourtalès, who had accompanied him to this country; Mr. E. Desor, who soon followed him to America; and Mr. Jaques Burkhardt, who had preceded them all, and

was now draughtsman in chief to the whole party. To his labors were soon added those of Mr. A. Sonrel, the able lithographic artist, who illustrated the most important works subsequently published by Agassiz. To an exquisite skill in his art he added a quick, intelligent perception of structural features from the naturalist's point of view, which made his work doubly valuable. Besides those abovementioned, there were several assistants who shared the scientific work in one department or another.

It must be confessed that this rather original establishment had the aspect of a laboratory rather than a home, domestic comfort being subordinate to scientific convenience. Every room served in some sort the purposes of an aquarium or a studio, while garret and cellar were devoted to collections. The rules of the household were sufficiently elastic to suit the most erratic student. A sliding scale for meals allowed the greatest freedom for excursions along the neighboring shores and beaches, and punctuality in work was the only punctuality demanded.

Agassiz himself was necessarily often absent, for the maintenance of the little colony depended in great degree upon his exertions.

During the winter of 1847, while continuing his lectures in Boston and its vicinity, he lectured in other places also. It is difficult to track his course at this time; but during the winters of 1847 and 1848 he lectured in all the large eastern cities, New York, Albany, Philadelphia, and Charleston, S. C. Everywhere he drew large crowds, and in those days his courses of lectures were rarely allowed to close without some public expression of gratitude and appreciation from the listeners. Among his papers are preserved several sets of resolutions from medical and scientific societies, from classes of students, and from miscellaneous audiences, attesting the enthusiasm awakened by his instruction. What he earned in this way enabled him to carry on his work and support his assistants. Still, the strain upon his strength, combined with all that he was doing beside in purely scientific work, was severe, and before the twelvemonth was out he was seriously ill. At this time Dr. B. E. Cotting, a physician whose position as curator of the Lowell Institute had brought him into contact with Agassiz, took him home to his house in the country, where he tended him through some weeks of tedious illness, hastening his convalescence by excur-

sions in all the neighboring country, from which they returned laden with specimens, — plants, birds, etc. In this hospitable home he passed his fortieth birthday, the first in this country. His host found him standing thoughtful and abstracted by the window. "Why so sad?" he asked. "That I am so old, and have done so little," was the answer. After some weeks he was able to return to his work, and the next letter gives some idea of his observations in the immediate vicinity of Boston, and especially in East Boston, where he was then living.

TO ELIE DE BEAUMONT.

BOSTON, *August* 31, 1847.

. . . I have waited to write until I should have some facts sufficiently important to claim your attention. In truth, the study of the marine animals, which I am, for the first time, able to observe in their natural conditions of existence, has engrossed me almost exclusively since I came to the United States, and only incidentally, as it were, I have turned my attention to paleontology and geology. I must, however, except the glacial phenomena, a problem, the solution of which always interests me deeply. This great ques-

tion, far from presenting itself more simply here, is complicated by peculiarities never brought to my notice in Europe. Happily for me, Mr. Desor, who had been in Scandinavia before joining me here, called my attention at once to certain points of resemblance between the phenomena there and those which I had seen in the neighborhood of Boston. Since then, we have made several excursions together, have visited Niagara, and, in short, have tried to collect all the special facts of glacial phenomena in America. Within a few days, however, I have come by chance upon something quite extraordinary and unexpected, which complicates the question anew. You are, no doubt, aware that the whole rocky surface of the ground here is polished. I do not think that anywhere in the world there exist polished and rounded rocks in better preservation or on a larger scale. Here, as elsewhere, erratic débris are scattered over these surfaces, scratched pebbles impacted in mud, forming unstratified masses mixed with and covered by large erratic boulders, more or less furrowed or scratched, the upper ones being usually angular and without marks. The absence of moraines, properly so-called, in a country so

little broken, is not surprising; I have, however, seen very distinct ones in some valleys of the White Mountains and in Vermont. Up to this time there had been nothing very new in the aspect of the phenomena as a whole; but on examining attentively the internal arrangement of all these materials, especially in the neighborhood of the sea, one soon becomes convinced that the ocean has partially covered and more or less remodeled them. In certain places there are patches of stratified sand interposed between masses of glacial drift-deposit; elsewhere, banks of sand and pebbles crown the irregularities of the glacial deposit, or fill in its depressions; in other localities the glacial pebbles may be washed and completely cleared of mud, retaining, however, their markings; or again, these markings may have disappeared, and the material is arranged in lines or ramparts, as it were, of diverse conformation, in which Mr. Desor recognized all the modifications of the "œsars" of Scandinavia. The disposition of the œsars, as seen here, is evidently due entirely to the action of the waves, and their frequency along the coast is a proof of this. In a late excursion with Captain Davis on board a government vessel I learned to

understand the mode of formation of the submarine dikes bordering the coast at various distances, which would be œsars were they elevated; with the aid of the dredge I satisfied myself of their identity. With these facts before me I cannot doubt that the œsars of the United States consist essentially of glacial material remodeled by the sea; while farther inland, though here and there reaching the sea-coast, we have unchanged glacial drift deposit. At some points the alteration is so slight as to denote only a momentary rise of the sea. Under these circumstances one would naturally look for fossils in the drift, and Mr. Desor, in company with Mr. de Pourtalès, was the first to find them, at Brooklyn, in Long Island, which lies to the south of New York. They were imbedded in a glacial clay deposit, having all the ordinary character of such deposits, with only slight traces of stratified sand. It is true that the greater number of these fossils (all belonging to species now living on the coast) were broken into angular fragments, not excepting even the thick tests of the Venus mercenaria.

But a few days ago, as I have said, a wider range was given to the field of our researches by an observation of mine. The suburb of

Boston where I am living (East Boston) is built on an island, one kilometer and a half long, extending from north to southeast, and varying in width at different points from two to six or seven hundred metres. Its height above the sea-level is about sixty feet. This little island is composed entirely of glacial muddy deposit, containing scratched pebbles mixed with larger boulders or blocks, and covered also with a considerable number of boulders of divers forms and dimensions. At East Boston you cannot see what underlies this deposit; but no doubt it rests upon a rounded mass of granite, polished and grooved like several others in Boston harbor. The house I occupy is on the southern slope of the island, and they are now digging more to the north, a new street parallel with one which runs along the shore. On the cuts of this excavation, at a depth of twelve feet below the surface, a bed of Zostera marina may be seen which crosses the whole hill almost horizontally, with a slight inclination to the northeast, thus forming a regular and continuous bank in the very middle of the drift. This bed of zostera, which, thanks to the excavations now making, I have been able to trace over an extent of several hundred metres in all direc-

tions, is several inches in thickness. The leaves of this plant, some specimens of which I inclose, are so well preserved that many still retain their green tint and even show the vessels and the grains of chlorophyll within. You would say the sea might have thrown them there only a few days since, so fresh do they seem; they might serve as stable litter, and yet they date back to the deposition of the drift, for the deposit which covers them is the same as that below them. Except the bed of zostera, deposited, no doubt, during a temporary encroachment of the sea, there is no other sign of the action of the water in all this part of the hill. Among the leaves of the zostera were found the greater part of the shells which now live along the coast and attach themselves upon this sea-weed, such as the Littorina rudis, Lacuna vincta, Lottia alveus, Mytilus plicatulus jeune, Spirorbis nautiloides; small polyps also, among others Tubulipora patina. Beside these, I have also found among them broken pieces of Limulus polyphemus and fragments of wood.

Thirty feet lower, that is to say, about twenty feet above the sea-level, on the southern slope of the hill, Mr. Desor found a bed of shells, extending all along the shore, essen-

tially composed of Mya arenaria, with some Natica heros and Purpura lapellus, all of which live now upon the shore; but we have not yet been able to ascertain whether this bank penetrates across the whole hill, like the bank of zostera.[1]

I abstain at present from any comment on these facts, and only insist upon the amazing freshness and remarkable state of preservation of the zostera and the fossils accompanying it. This is the more surprising, because in our journey to Niagara, Mr. Desor and I assured ourselves that the river deposits, in which, among other things, the mastodon is found with the fresh-water shells of Goat Island, are posterior to the drift. It is a fact worth consideration that the mastodons found in Europe are buried in true tertiary formations, while the great mastodon of the United States is certainly posterior to the drift. Shall I then dare to say that the fragments of wood found in the bed of zostera mentioned above are artificially modeled, and that, could one believe one's eyes, the traces of human in-

[1] I have satisfied myself that this bank of mya is simply shored up against the slope of the hill and does not penetrate the interior of the drift more than the bank of living mya on the present beach below.

dustry might be found in the cut of their surfaces? It certainly seems hardly credible, and yet so striking is the evidence before me that I hesitate to reject it. Or do the facts noticed by Lund, those of which Nilsson gives an account, and those which have been observed by Mr. Dickinson on the banks of the Mississippi, really indicate the existence of fossil men of different races from those now peopling the surface of the globe? And does the human genus reproduce, in the succession of its races, phenomena analogous to those of the succession of creations which have peopled the earth at different geological epochs? These are questions, the solution of which must be referred to the study of the most recent deposits, — a study we are only just now beginning, and the importance of which we can no longer disregard. But, however you may look upon these questions, you will surely agree with me that in the facts here stated, we have incontestable evidence of repeated upheavals of the coast of Massachusetts at a recent epoch, that is to say, posterior to the creation of animals and plants now inhabiting Boston Bay. The clear demarcation of the bed of zostera and of the bank of mya, and the absence of the latter anywhere

else on the slope of the hill, prove beside that these upheavals have not been continuous and uniform, but intermittent. . . . In another letter I will tell you something of my observations upon the geographical distribution of marine animals at different depths and on different bottoms, and also upon the relations between this distribution and that of the fossils in the tertiary deposits. . . .

CHAPTER XV.

1847 – 1850 : ÆT. 40 – 43.

Excursions on Coast Survey Steamer. — Relations with Dr. Bache, the Superintendent of the Coast Survey. — Political Disturbances in Switzerland. — Change of Relations with Prussia. — Scientific School established in Cambridge. — Chair of Natural History offered to Agassiz. — Acceptance. — Removal to Cambridge. — Literary and Scientific Associations there and in Boston. — Household in Cambridge. — Beginning of Museum. — Journey to Lake Superior. — "Report, with Narration." — "Principles of Zoölogy," by Agassiz and Gould. — Letters from European Friends respecting these Publications. — Letter from Hugh Miller. — Second Marriage. — Arrival of his Children in America.

One of Agassiz's great pleasures in the summer of 1847 consisted in excursions on board the Coast Survey steamer Bibb, then employed in the survey of the harbor and bay of Boston, under command of Captain (afterward Admiral) Charles Henry Davis. Under no more kindly auspices could Agassiz's relations with this department of government work have been begun. "My cabin," writes Captain Davis, after their first trip together, "seems lonely without you."

Hitherto the sea-shore had been a closed book to the Swiss naturalist, and now it opened to him a field of research almost as stimulating as his own glaciers. Born and bred among the mountains, he knew marine animals only as they can be known in dried and alcoholic specimens, or in a fossil state. From the Bibb he writes to a friend on shore: "I learn more here in a day than in months from books or dried specimens. Captain Davis is kindness itself. Everything I can wish for is at my disposal so far as it is possible."

Dr. Bache was at this time Superintendent of the Coast Survey, and he saw at once how the work of the naturalist might ally itself with the professional work of the Survey to the greater usefulness of both. From the beginning to the end of his American life, therefore, the hospitalities of the United States Coast Survey were open to Agassiz. As a guest on board her vessels he studied the reefs of Florida and the Bahama Banks, as well as the formations of our New England shores. From the deck of the Bibb, in connection with Count de Pourtalès, his first dredging experiments were undertaken; and his last long voyage around the continent, from Boston to San Francisco, was made on board the Hassler, a

Coast Survey vessel fitted out for the Pacific shore. Here was another determining motive for his stay in this country. Under no other government, perhaps, could he have had opportunities so invaluable to a naturalist.

But events were now passing in Europe which made his former position there, as well as that of many of his old friends, wholly unstable. In February, 1848, the proclamation of the French republic broke upon Europe like a clap of thunder from a clear sky. The news created great disturbances in Switzerland, and especially in the canton of Neuchâtel, where a military force was immediately organized by the republican party in opposition to the conservatives, who would fain have continued loyal to the Prussian king. For the moment all was chaos, and the prospects of institutions of learning were seriously endangered. The republican party carried the day; the canton of Neuchâtel ceased to be a dependence of the Prussian monarchy, and became merged in the general confederation of Switzerland.

At about the same time that Agassiz, in consequence of this change of conditions, was honorably discharged from the service of the Prussian king, a scientific school was organ-

ized at Cambridge, Massachusetts, in direct connection with Harvard University. This school, known as the Lawrence Scientific School, owed its existence to the generosity of Abbott Lawrence, formerly United States Minister at the Court of St. James. He immediately offered the chair of Natural History (Zoölogy and Geology) to Agassiz, with a salary of fifteen hundred dollars, guaranteed by Mr. Lawrence himself, until such time as the fees of the students should be worth three thousand dollars to their professor. This time never came. Agassiz's lectures, with the exception of the more technical ones addressed to small classes, were always fully attended, but special students were naturally very few in a department of pure science, and their fees never raised the salary of the professor perceptibly. This was, however, counterbalanced in some degree by the clause in his contract which allowed him entire freedom for lectures elsewhere, so that he could supplement his restricted income from other sources.

In accordance with this new position Agassiz now removed his bachelor household to Cambridge, where he opened his first course in April, 1848. He could hardly have come to Harvard at a more auspicious moment, so

far as his social and personal relations were concerned. The college was then on a smaller scale than now, but upon its list of professors were names which would have given distinction to any university. In letters, there were Longfellow and Lowell, and Felton, the genial Greek scholar, of whom Longfellow himself wrote, "In Attica thy birthplace should have been." In science, there were Peirce, the mathematician, and Dr. Asa Gray, then just installed at the Botanical Garden, and Jeffries Wyman, the comparative anatomist, appointed at about the same time with Agassiz himself. To these we might almost add, as influencing the scientific character of Harvard, Dr. Bache, the Superintendent of the Coast Survey, and Charles Henry Davis, the head of the Nautical Almanac, since the kindly presence of the former was constantly invoked as friend and counselor in the scientific departments, while the latter had his residence in Cambridge, and was as intimately associated with the interests of Harvard as if he had been officially connected with the university.

A more agreeable set of men, or one more united by personal relations and intellectual aims, it would have been difficult to find. In connection with these names, those of Prescott,

Ticknor, Motley, and Holmes also arise most naturally, for the literary men and scholars of Cambridge and Boston were closely united; and if Emerson, in his country home at Concord, was a little more withdrawn, his influence was powerful in the intellectual life of the whole community, and acquaintance readily grew to friendship between him and Agassiz. Such was the pleasant and cultivated circle into which Agassiz was welcomed in the two cities, which became almost equally his home, and where the friendships he made gradually transformed exile into household life and ties.

In Cambridge he soon took his share in giving as well as receiving hospitalities, and his Saturday evenings were not the less attractive because of the foreign character and somewhat unwonted combination of the household. Over its domestic comforts now presided an old Swiss clergyman, Monsieur Christinat. He had been attached to Agassiz from childhood, had taken the deepest interest in his whole career, and, as we have seen, had assisted him to complete his earlier studies. Now, under the disturbed condition of things at home, he had thrown in his lot with him in America. "If your old friend," he writes, "can live

with his son Louis, it will be the height of his happiness." To Agassiz his presence in the house was a benediction. He looked after the expenses, and acted as commissary in chief to the colony. Obliged, as Agassiz was, frequently to be absent on lecturing tours, he could, with perfect security, intrust the charge of everything connected with the household to his old friend, from whom he was always sure of an affectionate welcome on his return. In short, so far as an old man could, "papa Christinat," as he was universally called in this miscellaneous family, strove to make good to him the absence of wife and children.

The make-up of the settlement was somewhat anomalous. The house, though not large, was sufficiently roomy, and soon after Agassiz was established there he had the pleasure of receiving under his roof certain friends and former colleagues, driven from their moorings in Europe by the same disturbances which had prevented him from returning there. The arrival among them of Mr. Guyot, with whom his personal and scientific intimacy was of such long standing, was a great happiness. It was especially a blessing at this time, for troubles at home weighed upon Agassiz and depressed him. His wife,

always delicate in health, had died, and although his children were most affectionately provided for in her family and his own, they were separated from each other, as well as from him; nor did he think it wise to bring them while so young, to America. The presence, therefore, of one who was almost like a brother in sympathy and companionship, was now more than welcome. His original staff of co-workers and assistants still continued with him, and there were frequent guests besides, chiefly foreigners, who, on arriving in a new country, found their first anchorage and point of departure in this little European settlement.

The house stood in a small plot of ground, the cultivation of which was the delight of papa Christinat. It soon became a miniature zoölogical garden, where all sorts of experiments in breeding and observations on the habits of animals, were carried on. A tank for turtles and a small alligator in one corner, a large hutch for rabbits in another, a cage for eagles against the wall, a tame bear and a family of opossums, made up the menagerie, varied from time to time by new arrivals.

But Agassiz could not be long in any place without beginning to form a museum. When

he accepted the chair offered him at Cambridge, there were neither collections nor laboratories belonging to his department. The specimens indispensable to his lectures were gathered almost by the day, and his outfit, with the exception of the illustrations he had brought from Europe, consisted of a blackboard and a lecture-room. There was no money for the necessary objects, and the want of it had to be supplied by the professor's own industry and resources. On the banks of the Charles River, just where it is crossed by Brighton Bridge, was an old wooden shanty set on piles; it might have served perhaps, at some time, as a bathing or a boat house. The use of this was allowed Agassiz for the storing of such collections as he had brought together. Boards nailed against the walls served for cases, and with a deal table or two for dissection this rough shelter was made to do duty as a kind of laboratory. The fact is worth noting, for this was the beginning of the Museum of Comparative Zoölogy in Cambridge, now admitted to a place among the great institutions of its kind in the world.

In the summer of 1848 Agassiz organized an expedition entirely after his own heart, in-

asmuch as it combined education with observation in the field. The younger portion of the party consisted of several of his special pupils, and a few other Harvard students who joined the expedition from general interest. Beside these, there were several volunteer members, who were either naturalists or had been attracted to the undertaking by their love of nature and travel. Their object was the examination of the eastern and northern shores of Lake Superior from Sault Ste. Marie to Fort William, a region then little known to science or to tourists. Agassiz taught along the road. At evening, around the camp-fire, or when delayed by weather or untoward circumstances, he would give to his companions short and informal lectures, it might be on the forest about them, or on the erratic phenomena in the immediate neighborhood, — on the terraces of the lake shore, or on the fish of its waters. His lecture-room, in short, was everywhere; his apparatus a traveling blackboard and a bit of chalk; while his illustrations and specimens lay all around him, wherever the party chanced to be.

To Agassiz himself the expedition was of the deepest interest. Glacial phenomena had, as we have seen, met him at every turn since

his arrival in the United States, but nowhere had he found them in greater distinctness than on the shores of Lake Superior. As the evidence accumulated about him, he became more than ever satisfied that the power which had modeled and grooved the rocks all over the country, and clothed it with a sheet of loose material reaching to the sea, must have been the same which had left like traces in Europe. In a continent of wide plains and unbroken surfaces, and, therefore, with few centres of glacial action, the phenomena were more widely and uniformly scattered than in Europe. But their special details, down to the closest minutiæ, were the same, while their definite circumscription and evenness of distribution forbade the idea of currents or floods as the moving cause. Here, as elsewhere, Agassiz recognized at once the comprehensive scope of the phenomena. The whole history reconstructed itself in his mind, to the time when a sheet of ice clothed the land, reaching the Atlantic sea-board, as it now does the coast of Spitzbergen and the Arctic shores.

He made also a careful survey of the local geology of Lake Superior, and especially of the system of dykes, by the action of which

he found that its bed had been excavated, and the outline of its shores determined. But perhaps the inhabitants of the lake itself occupied him even more than its conformation or its surrounding features. Not only for its own novelty and variety, but for its bearing on the geographical distribution of animals, the fauna of this great sheet of fresh water interested him deeply. On this journey he saw at Niagara for the first time a living gar-pike, the only representative among modern fishes of the fossil type of Lepidosteus. From this type he had learned more perhaps than from any other, of the relations between the past and the present fishes. When a student of nineteen years of age, his first sight of a stuffed skin of a gar-pike in the Museum of Carlsruhe told him that it stood alone among living fishes. Its true alliance with the Lepidosteus of the early geological ages became clear to him only later in his study of the fossil fishes. He then detected the reptilian character of the type, and saw that from the articulation of the vertebræ the head must have moved more freely on the trunk than that of any fish of our days. To his great delight, when the first living specimen of the gar-pike, or modern Lepidosteus,

was brought to him, it moved its head to the right and left and upward, as a Saurian does and as no other fish can.

The result of this expedition was a valuable collection of fishes and a report upon the fauna and the geology of Lake Superior, comprising the erratic phenomena. A narrative written by James Elliot Cabot formed the introduction to the report, and it was also accompanied by two or three shorter contributions on special subjects from other members of the party. The volume was illustrated by a number of plates exquisitely drawn and colored on stone by A. Sonrel.

This was not Agassiz's first publication in America. His "Principles of Zoölogy" (Agassiz and Gould) was published in 1848. The book had a large sale, especially for schools. Edition followed edition, but the sale of the first part was checked by the want of the second, which was never printed. Agassiz was always swept along so rapidly by the current of his own activity that he was sometimes forced to leave behind him unfinished work. Before the time came for the completion of the second part of the zoölogy, his own knowledge had matured so much, that to be true to the facts, he must have remodeled the

whole of the first part, and for this he never found the time. Apropos of these publications the following letters are in place.

FROM SIR RODERICK MURCHISON.

BELGRAVE SQUARE, *October* 3, 1849.

. . . I thank you very sincerely for your most captivating general work on the "Principles of Zoölogy." I am quite in love with it. I was glad to find that you had arranged the nummulites with the tertiary rocks, so that the broad generalization I attempted in my last work on the Alps, Apennines, and Carpathians is completely sustained zoölogically, and you will not be sorry to see the stratigraphical truth vindicated (versus E. de Beaumont and ——). I beseech you to look at my memoir, and especially at my reasoning about the miocene and pliocene divisions of the Alps and Italy. It seems to me manifest that the percentage system derived from marine life can never be applied to tertiary *terrestrial* successions. . . .

My friends have congratulated me much on this my last effort, and as Lyell and others most interested in opposing me have been forward in approval, I begin to hope that I am not yet quite done up; and that unlike

the Bishop of Oviedo, my last sermon "ne sent pas de l'apoplexie." I have, nevertheless, been desperately out of sorts and full of gout and liver and all kinds of irritation this summer, which is the first for many a long year in which I have been unable to take the field. The meeting at Birmingham, however, revived me. Professor W. Rogers will have told you all about our doings. Buckland is up to his neck in "sewage," and wishes to change all underground London into a fossil cloaca of pseudo coprolites. This does not quite suit the chemists charged with sanitary responsibilities; for they fear the Dean will poison half the population in preparing his choice manures! But in this as in everything he undertakes there is a grand sweeping view.

When are we to meet again? And when are we to have a "stand-up fight" on the erratics of the Alps? You will see by the abstract of my memoir appended to my Alpine affair that I have taken the field against the extension of the Jura! In a word, I do not believe that great trunk glaciers ever filled the valleys of the Rhone, etc. Perhaps you will be present at our next meeting of the British Association at Edinburgh, August,

1850. *Olim meminisse juvabit!* and then, my dear and valued and most enlightened friend, we may study once more together the surface of my native rocks for "auld lang syne." . . .

FROM CHARLES DARWIN.

DOWN, FARNBOROUGH, KENT,
June 15 [1850, probably].

MY DEAR SIR, — I have seldom been more deeply gratified than by receiving your most kind present of "Lake Superior." I had heard of it, and had much wished to read it, but I confess it was the very great honor of having in my possession a work with your autograph, as a presentation copy, that has given me such lively and sincere pleasure. I cordially thank you for it. I have begun to read it with uncommon interest, which I see will increase as I go on.

The Cirrepedia, which you and Dr. Gould were so good as to send me, have proved of great service to me. The sessile species from Massachusetts consist of five species. . . . Of the genus Balanus, on the shores of Britain, we have *one* species (B. perforata Bruguière), which you have not in the United States, in the same way as you exclusively

have B. eburneus. All the above species attain a somewhat larger average size on the shores of the United States than on those of Britain, but the specimens from the glacial beds of Uddevalla, Scotland, and Canada, are larger even than those of the United States.

Once again allow me to thank you with cordiality for the pleasure you have given me.

Believe me, with the highest respect, your truly obliged,

C. DARWIN.

The following letter from Hugh Miller concerning Agassiz's intention of introducing "The Footprints of the Creator" to the American public by a slight memoir of Miller is of interest here. It is to be regretted that with this exception no letters have been found from him among Agassiz's papers, though he must have been in frequent correspondence with him, and they had, beside their scientific sympathy, a very cordial personal relation.

EDINBURGH, 2 STUART STREET, *May* 25, 1850.

DEAR SIR, — I was out of town when your kind letter reached here, and found such an accumulation of employment on my return that it is only now I find myself able to devote

half an hour to the work of reply, and to say how thoroughly sensible I am of the honor you propose doing me. It never once crossed my mind when, in writing my little volume, the "Footprints," I had such frequent occasion to refer to my master, our great authority in ichthyic history, that he himself would have associated his name with it on the other side of the Atlantic, and referred in turn to its humble writer.

In the accompanying parcel I send you two of my volumes, which you may not yet have seen, and in which you may find some materials for your proposed introductory memoir. At all events they may furnish you with amusement in a leisure hour. The bulkier of the two, "Scenes and Legends," of which a new edition has just appeared, and of which the first edition was published, after lying several years beside me, in 1835, is the earliest of my works to which I attached my name. It forms a sort of traditionary history of a district of Scotland, about two hundred miles distant from the capital, in which the character of the people has been scarce at all affected by the cosmopolitanism which has been gradually modifying and altering it in the larger towns; and as it has been fre-

quently remarked, — I know not with what degree of truth, — that there is a closer resemblance between the Scotch and Swiss than between any other two peoples of Europe, you may have some interest in determining whether the features of your own countryfolk are not sometimes to be seen in those of mine, as exhibited in my legendary history. Certainly both countries had for many ages nearly the same sort of work to do; both had to maintain a long and ultimately successful war of independence against nations greatly more powerful than themselves; and as their hills produced little else than the "soldier and his sword," both had to make a trade abroad of that art of war which they were compelled in self-defense to acquire at home. Even in the laws of some nations we find them curiously enough associated together. In France, under the old régime, the personal property of all strangers dying in the country, *Swiss and Scots excepted*, was forfeited to the king.

The other volume, "First Impressions of England and its People," contains some personal anecdotes and some geology. But the necessary materials you will chiefly find in the article from the "North British Review" which I also inclose. It is from the pen of

Sir David Brewster, with whom for the last ten years I have spent a few very agreeable days every year at Christmas, under the roof of a common friend, — one of the landed proprietors of Fifeshire. Sir David's estimate of the writer is, I fear, greatly too high, but his statement of facts regarding him is correct; and I think you will find it quite full enough for the purposes of a brief memoir. With his article I send you one of my own, written about six years ago for the same periodical, as the subject is one in which, from its connection with your master study, — the natural history of fishes, — you may take more interest than most men. It embodies, from observation, what may be regarded as *the natural history of the fisherman*, and describes some curious scenes and appearances which I witnessed many years ago when engaged, during a truant boyhood, in prosecuting the herring fishery as an amateur. Many of my observations of natural phenomena date from this idle, and yet not wholly wasted, period of my life.

With the volumes I send also a few casts of my less fragile specimens of Asterolepis. Two of the number, those of the external and internal surfaces of the creature's cranial buck-

ler, are really very curious combinations of plates, and when viewed in a slant light have a decidedly sculpturesque and not ungraceful effect. I have seen on our rustic tombstones worse representations of angels, winged and robed, than that formed by the central plates of the interior surface when the light is made to fall along their higher protuberances, leaving the hollows in the shade. You see how truly your prediction regarding the flatness of the creature's head is substantiated by these casts; it is really not easy to know how, placed on so flat a surface, the eyes could have been very available save for star-gazing; but as nature makes no mistakes in such matters, it is possible that the creature, like the flatfishes, may have lived much at the bottom, and that most of the seeing it had use for may have been seeing in an upward direction. None of my other specimens of bucklers are so entire and in so good a state of keeping as the two from which I have taken the casts, but they are greatly larger. One specimen, nearly complete, exhibits an area about four times as great as the largest of these two, and I have fragments of others which must have belonged to fish still more gigantic. The two other casts are of specimens of gill covers,

which in the Asterolepis, as in the sturgeon, consisted each of a single plate. In both the exterior surface of the buckler and of the operculum the tubercles are a good deal enveloped in the stone, which is of a consistency too hard to be removed without injuring what it overlies; but you will find them in the smaller cast which accompanies the others, and which, as shown by the thickness of the plate in the original, indicates their size and form in a large individual, very characteristically shown. So coral-like is their aspect, that if it was from such a cast, not a fossil (which would, of course, exhibit the peculiarities of the bone), that Lamarck founded his genus Monticularia, I think his apology for the error might almost be maintained as good. I am sorry I cannot venture on taking casts from some of my other specimens; but they are exceedingly fragile, and as they are still without duplicates I am afraid to hazard them. Since publishing my little volume I have got several new plates of Asterolepis, — a broad palatal plate, covered with tubercles, considerably larger than those of the creature's external surface, — a key-stone shaped plate, placed, when *in situ*, in advance of the little plate between the eyes, which form the head

and face of the effigy in the centre of the buckler, — and a side-plate, into which the condyloid processes of the lower jaw were articulated, and which exhibited the processes on which these hinged. There are besides some two or three plates more, whose places I have still to find. The small cast, stained yellow, is taken from an instructive specimen of the jaws of coccosteus, and exhibits a peculiarity which I had long suspected and referred to in the first edition of my volume on the Old Red Sandstone in rather incautious language, but which a set of my specimens now fully establishes. Each of the under jaws of the fish was furnished with two groups of teeth: one group in the place where, in quadrupeds, we usually find the molars; and another group in the line of the symphyses. And how these both could have acted is a problem which our anatomists here — many of whom have carefully examined my specimen — seem unable, and in some degree, indeed, afraid to solve.

I have written to the Messrs. Gould, Kendall & Lincoln to say that the third edition of the "Footprints" differs from the first and second only by the addition of a single note and an illustrative diagram, both of which I

have inclosed to them in my communication. I anticipate much pleasure from the perusal of your work on Lake Superior, when it comes to hand, which, as your publishers have intrusted it to the care of a gentleman visiting this country, will, I think, be soon. It is not often that a region so remote and so little known as that which surrounds the great lake of America is visited by a naturalist of the first class. From such a *terra incognita*, at length unveiled to eyes so discerning, I anticipate strange tidings.

I am, my dear sir, with respect and admiration, very truly yours,

HUGH MILLER.

In the spring of 1850 Agassiz married Elizabeth Cabot Cary, daughter of Thomas Graves Cary, of Boston. This marriage confirmed his resolve to remain, at least for the present, in the United States. It connected him by the closest ties with a large family circle, of which he was henceforth a beloved and honored member, and made him the brother-in-law of one of his most intimate friends in Cambridge, Professor C. C. Felton. Thus secure of favorable conditions for the care and education of his children, he called

them to this country. His son (then a lad of fifteen years of age) had joined him the previous summer. His daughters, younger by several years than their brother, arrived the following autumn, and home built itself up again around him.

The various foreign members of his household had already scattered. One or two had returned to Europe, others had settled here in permanent homes of their own. Among the latter were Professor Guyot and M. de Pourtalès, who remained, both as scientific colleagues and personal friends, very near and dear to him all his life. "Papa Christinat" had also withdrawn. While Agassiz was absent on a lecturing tour, the kind old man, knowing well the opposition he should meet, and wishing to save both himself and his friend the pain of parting, stole away without warning and went to New Orleans, where he had obtained a place as pastor. This was a great disappointment to Agassiz, who had urged him to make his home with him, a plan in which his wife and children cordially concurred, but which did not approve itself to the judgment of his old friend. M. Christinat afterward returned to Switzerland, where he ended his days. He wrote constantly until

his death, and was always kept advised of everything that passed in the family at Cambridge. Of the old household, Mr. Burkhardt alone remained a permanent member of the new one.

CHAPTER XVI.

1850 – 1852 : ÆT. 43–45.

Proposition from Dr. Bache. — Exploration of Florida Reefs. — Letter to Humboldt concerning Work in America. — Appointment to Professorship of Medical College in Charleston, S. C. — Life at the South. — Views concerning Races of Men. — Prix Cuvier.

THE following letter from the Superintendent of the Coast Survey determined for Agassiz the chief events of the winter of 1851.

FROM ALEXANDER DALLAS BACHE.

WEBB'S HILL, *October* 30, 1850.

MY DEAR FRIEND, — Would it be possible for you to devote six weeks or two months to the examination of the Florida reefs and keys in connection with their survey? It is extremely important to ascertain what they are and how formed. One account treats them as growing corals, another as masses of something resembling oölite, piled together, barrier-wise. You see that this lies at the root of the progress of the reef, so important to

navigation, of the use to be made of it in placing our signals, of the use as a foundation for light-houses, and of many other questions practically important and of high scientific interest. I would place a vessel at your disposal during the time you were on the reef, say six weeks.

The changes at or near Cape Florida, from the Atlantic coast and its silicious sand, to the Florida coast and its coral sand, must be curious. You will be free to move from one end of the reef to the other, which will be, say one hundred and fifty miles. Motion to eastward would be slow in the windy season, though favored by the Gulf Stream as the winds are "trade." Whatever collections you might make would be your own. I would only ask for the survey such information and such specimens as would be valuable to its operations, especially to its hydrography, and some report on these matters. As this will, if your time and engagements permit, lead to a business arrangement, I must, though reluctantly, enter into that. I will put aside six hundred dollars for the two months, leaving you to pay your own expenses; or, if you prefer it, will pay all expenses of travel, including subsistence, to and from Key West,

and furnish vessel and subsistence while there, and four hundred dollars.

What results would flow to science from your visit to that region! You have spoken of the advantage of using our vessels when they were engaged in their own work. Now I offer you a vessel the motions of which you will control, and the assistance of the officers and crew of which you will have. You shall be at no expense for going and coming, or while there, and shall choose your own time. . . .

Agassiz accepted this proposal with delight, and at once made arrangements to take with him a draughtsman and an assistant, in order to give the expedition such a character as would make it useful to science in general, as well as to the special objects of the Coast Survey. It will be seen that Dr. Bache gladly concurred in all these views.

FROM ALEXANDER DALLAS BACHE.

WASHINGTON, *December* 18, 1850.

MY DEAR FRIEND, — On the basis of our former communications I have been, as the time served, raising a superstructure. I have arranged with Lieutenant Commander Alden

to send the schooner W. A. Graham, belonging to the Coast Survey, under charge of an officer who will take an interest in promoting the great objects in which you will be engaged, to Key West, in time to meet you on your arrival in the Isabel of the 15th, from Charleston to Key West. The vessel will be placed at your absolute disposal for four to six weeks, as you may find desirable, doing just such things as you require, and going to such places as you direct. If you desire more than a general direction, I will give any specific ones which you may suggest. . . .

I have requested that room be made in the cabin for you and for two aids, as you desire to take a draughtsman with you; and in reference to your enlarged plan of operating, of which I see the advantage, I have examined the financial question, and propose to add two hundred dollars to the six hundred in my letter of October 30th, to enable you to execute it. I would suggest that you stop a day in Washington on your way to Charleston, to pick up the topographical and geographical information which you desire, and to have all matters of a formal kind arranged to suit your convenience and wishes, which, I am sure, will all be promotive of the objects in

view from your visit to Florida. . . . You say I shall smile *at* your plans, — instead of which, they have been smiled *on ;* now, there is a point for you, — a true Saxon distinction.

If you succeed (and did you ever fail !?) in developing for our Coast Survey the nature, structure, growth, and all that, of the Florida reefs, you will have conferred upon the country a priceless favor. . . .

The Superintendent of the Coast Survey never had cause to regret the carte-blanche he had thus given. A few weeks, with the facilities so liberally afforded, gave Agassiz a clew to all the phenomena he had been commissioned to examine, and enabled him to explain the relation between the keys and the outer and inner reefs, and the mud swamps, or more open channels, dividing them, and to connect these again with the hummocks and everglades of the main-land. It remains to be seen whether his theory will hold good, that the whole or the greater part of the Florida peninsula has, like its southern portion, been built up of concentric reefs. But his explanation of the present reefs, their structure, laws of growth, relations to each other and to the main-land, as well as to the Gulf

Stream and its prevailing currents, was of great practical service to the Coast Survey. It was especially valuable in determining how far the soil now building up from accumulations of mud and coral débris was likely to remain for a long time shifting and uncertain, and how far and in what localities it might be relied upon as affording a stable foundation. When, at the meeting of the American Association in the following spring, Agassiz gave an account of his late exploration, Dr. Bache, who was present, said that for the first time he understood the bearing of the whole subject, though he had so long been trying to unravel it.

The following letter was written immediately after Agassiz's return.

TO SIR CHARLES LYELL.

CAMBRIDGE, *April* 26, 1851.

. . . I have spent a large part of the winter in Florida, with a view of studying the coral reefs. I have found that they constitute a new class of reefs, distinct from those described by Darwin and Dana under the name of fringing reefs, barrier reefs, and atolls. I have lately read a paper upon that subject before the American Academy, which

I shall send you as soon as it is printed. The case is this. There are several concentric reefs separated by deep channels; the peninsula of Florida itself is a succession of such reefs, the everglades being the filled-up channels, while the hummocks were formerly little intervening islands, like the mangrove islands in the present channels. But what is quite remarkable, all these concentric reefs are upon one level, above that of the sea, and there is no indication whatever of upheaval. You will find some observations upon upheavals, etc., in Silliman, by Tuomey; it is a great mistake, as I shall show. The Tortugas are a real atoll, but formed without the remotest indication of subsidence.

Of course this does not interfere in the least with the views of Darwin, for the whole ground presents peculiar features. I wish you would tell him something about this. One of the most remarkable peculiarities of the rocks in the reefs of the Tortugas consists in their composition; they are chiefly made up of *Corallines*, limestone algæ, and, to a small extent only, of real corals. . . .

Agassiz's report to the Coast Survey upon the results of this first investigation made by

him upon the reefs of Florida was not published in full at the time. The parts practically most important to the Coast Survey were incorporated in their subsequent charts; the more general scientific results, as touching the physical history of the peninsula as a whole, appeared in various forms, were embodied in Agassiz's lectures, and were printed some years after in his volume entitled "Methods of Study." The original report, with all the plates prepared for it, was published in the "Memoirs of the Museum of Comparative Zoölogy," under the supervision of Alexander Agassiz, after the death of his father. It forms a quarto volume, containing some sixty pages of text, with twenty-two plates, illustrative of corals and coral structure, and a map of Southern Florida with its reefs and keys.

This expedition was also of great importance to Agassiz's collections, and to the embryo museum in Cambridge. It laid the foundation of a very complete collection of corals of all varieties and in all stages of growth. All the specimens, from huge coral heads and branching fans down to the most minute single corals, were given up to him, the value of the whole being greatly enhanced by the drawings taken on the spot from the living animals.

To this period belongs also the following fragment of a letter to Humboldt.

TO ALEXANDER VON HUMBOLDT.

[Probably 1852, — date not given.]

. . . What a time has passed since my last letter! Had you not been constantly in my thoughts, and your counsels always before me as my guide, I should reproach myself for my silence. I hope my two papers on the medusæ, forwarded this year, have reached you, and also one upon the classification of insects, as based upon their development. I have devoted myself especially to the organization of the invertebrate animals, and to the facts bearing upon the perfecting of their classification. I have succeeded in tracing the same identity of structure between the three classes of radiates, and also between those of mollusks, as has already been recognized in the vertebrates, and partially in the articulates. It is truly a pleasure for me now to be able to demonstrate in my lectures the insensible gradations existing between polyps, medusæ, and echinoderms, and to designate by the same name organs seemingly so different. Especially has the minute examination of the thickness of the test in echinoderms revealed

to me unexpected relations between the sea-urchin and the medusa. No one suspects, I fancy, at this moment, that the solid envelope of the Scutellæ and the Clypeasters is traversed by a net-work of radiating tubes, corresponding to those of the medusæ, so well presented by Ehrenberg in Aurelia aurita. If the Berlin zoölogists will take the trouble to file off the surface of the test of an Echinarachnius parma, they will find a circular canal as large and as continuous as that of the medusæ. The aquiferous tubes specified above open into this canal. But the same thing may be found under various modifications in other genera of the family. Since I have succeeded in injecting colored liquid into the beroids, for instance, and keeping them alive with it circulating in their transparent mass, I am able to show the identity of their zones of locomotive fringes (combs), from which they take their name of Ctenophoræ, with the ambulacral (locomotive) apparatus of the echinoderms. Furnished with these facts, it is not difficult to recognize true beroidal forms in the embryos of sea-urchins and star-fishes, published by Müller in his beautiful plates, and thus to trace the medusoid origin of the echinoderms, as the polypoid origin of the

medusæ has already been recognized. I do not here allude to their primitive origin, but simply to the general fact that among radiates the embryos of the higher classes represent, in miniature, types of the lower classes, as, for instance, those of the echinoderms resemble the medusæ, those of the medusæ the polyps. Having passed the greater part of last winter in Florida, where I was especially occupied in studying the coral reefs, I had the best opportunity in the world for prosecuting my embryological researches upon the stony corals. I detected relations among them which now enable me to determine the classification of these animals according to their mode of development with greater completeness than ever before, and even to assign a superior or inferior rank to their different types, agreeing with their geological succession, as I have already done for the fishes. I am on the road to the same results for the mollusks and the articulates, and can even now say in general terms, that the most ancient representatives of all the families belonging to these great groups, strikingly recall the first phases in the embryonic development of their successors in more recent formations, and even that the embryos of comparatively recent

families recall families belonging to ancient epochs. You will find some allusion to these results in my Lectures on Embryology, given in my "Lake Superior," of which I have twice sent you a copy, that it might reach you the more surely; but these first impressions have assumed greater coherence now, and I constantly find myself recurring to my fossils for light upon the embryonic forms I am studying and *vice versa*, consulting my embryological drawings in order to decipher the fossils with greater certainty.

The proximity of the sea and the ease with which I can visit any part of the coast within a range of some twenty degrees give me inexhaustible resources for the whole year, which, as time goes on, I turn more and more to the best account. On the other hand, the abundance and admirable state of preservation of the fossils found in our ancient deposits, as well as the regular succession of the beds containing them, contribute admirable material for this kind of comparative study. . . .

In the summer of 1851 Agassiz was invited to a professorship at the Medical College in Charleston, S. C. This was especially ac-

ceptable to him, because it substituted a regular course of instruction to students, for the disconnected lectures given to miscellaneous audiences, in various parts of the country, by which he was obliged to eke out his small salary and provide for his scientific expenses. While more fatiguing than class-room work, these scattered lectures had a less educational value, though, on the other hand, they awakened a very wide-spread interest in the study of nature. The strain of constant traveling for this purpose, the more harassing because so unfavorable to his habits of continuous work, had already told severely upon his health; and from this point of view also the new professorship was attractive, as promising a more quiet, though no less occupied, life. The lectures were to be given during the three winter months, thus occupying the interval between his autumn and spring courses at Cambridge.

He assumed his new duties at Charleston in December, 1851, and by the kindness of his friend Mrs. Rutledge, who offered him the use of her cottage for the purpose, he soon established a laboratory on Sullivan's Island, where the two or three assistants he had brought with him could work conveniently.

The cottage stood within hearing of the wash of the waves, at the head of the long, hard sand beach which fringed the island shore for some three or four miles. There could hardly be a more favorable position for a naturalist, and there, in the midst of their specimens, Agassiz and his band of workers might constantly be found. His studies here were of the greater interest to him because they connected themselves with his previous researches, not only upon the fishes, but also upon the lower marine animals of the coast of New England and of the Florida reefs; so that he had now a basis for comparison of the fauna scattered along the whole Atlantic coast of the United States. The following letter gives some idea of his work at this time.

TO PROFESSOR JAMES D. DANA.

CHARLESTON, *January* 26, 1852.

MY DEAR FRIEND, — You should at least know that I think of you often on these shores. And how could I do otherwise when I daily find new small crustacea, which remind me of the important work you are now preparing on that subject.

Of course, of the larger ones there is nothing to be found after Professor Gibbes has gone

over the ground, but among the lower orders there are a great many in store for a microscopic observer. I have only to regret that I cannot apply myself more steadily. I find my nervous system so over-excited that any continuous exertion makes me feverish. So I go about as much as the weather allows, and gather materials for better times.

Several interesting medusæ have been already observed; among others, the entire metamorphosis and alternate generation of a new species of my genus tiaropsis. You will be pleased to know that here, as well as at the North, tiaropsis is the medusa of a campanularia. Mr. Clark, one of my assistants, has made very good drawings of all its stages of growth, and of various other hydroid medusæ peculiar to this coast. Mr. Stimpson, another very promising young naturalist, who has been connected with me for some time in the same capacity, draws the crustacea and bryozoa, of which there are also a good many new ones here. My son and my old friend Burkhardt are also with me (upon Sullivan's Island), and they look after the larger species, so that I shall probably have greatly increased my information upon the fauna of the Atlantic coast by the time I return to Cambridge.

In town, where I go three times a week to deliver lectures at the Medical College (beside a course just now in the evening also before a mixed audience), I have the rest of my family, so that nothing would be wanting to my happiness if my health were only better. . . . What a pity that a man cannot work as much as he would like; or at least accomplish what he aims at. But no doubt it is best it should be so; there is no harm in being compelled by natural necessities to limit our ambition, — on the contrary, the better sides of our nature are thus not allowed to go to sleep. However, I cannot but regret that I am unable at this time to trace more extensively subjects for which I would have ample opportunities here, as for instance the anatomy of the echinoderms, and also the embryology of the lower animals in general. . . .

This winter, notwithstanding the limitations imposed upon his work by the state of his health, was a very happy one to Agassiz. As mentioned in the above letter his wife and daughters had accompanied him to Charleston, and were established there in lodgings. Their holidays and occasional vacations were passed at the house of Dr. John E. Holbrook

(the "Hollow Tree"), an exquisitely pretty and picturesque country place in the neighborhood of Charleston. Here Agassiz had been received almost as one of the family on his first visit to Charleston, shortly after his arrival in the United States. Dr. Holbrook's name, as the author of the "Herpetology of South Carolina," had long been familiar to him, and he now found a congenial and affectionate friend in the colleague and fellow-worker, whose personal acquaintance he had been anxious to make. Dr. Holbrook's wife, a direct descendant of John Rutledge of our revolutionary history, not only shared her husband's intellectual life, but had herself rare mental qualities, which had been developed by an unusually complete and efficient education. The wide and various range of her reading, the accuracy of her knowledge in matters of history and literature, and the charm of her conversation, made her a delightful companion. She exercised the most beneficent influence upon her large circle of young people, and without any effort to attract, she drew to herself whatever was most bright and clever in the society about her. The "Hollow Tree," presided over by its hospitable host and hostess was, therefore,

the centre of a stimulating and cultivated social intercourse, free from all *gêne* or formality. Here Agassiz and his family spent many happy days during their southern sojourn of 1852. The woods were yellow with jessamine, and the low, deep piazza was shut in by vines and roses; the open windows and the soft air full of sweet, out-of-door fragrance made one forget, spite of the wood fire on the hearth, that it was winter by the calendar. The days, passed almost wholly in the woods or on the veranda, closed with evenings spent not infrequently in discussions upon the scientific ideas and theories of the day, carried often beyond the region of demonstrated facts into that of speculative thought. An ever-recurring topic was that of the origin of the human race. It was Agassiz's declared belief that man had sprung not from a common stock, but from various centres, and that the original circumscription of these primordial groups of the human family corresponded in a large and general way with the distribution of animals and their combination into faunæ.[1] His special zoölogical studies were too en-

[1] See *Sketch of the Natural Provinces of the Animal World and their Relation to the Different Types of Man* included in Nott & Gliddon's *Types of Mankind.*

grossing to allow him to follow this line of investigation closely, but it was never absent from his view of the animal kingdom as a whole. He valued extremely Mrs. Holbrook's thoughtful sympathy, and as the following letter connects itself with the winter evening talks by the "Hollow Tree" fireside, and was suggested by them, it may be given here, though in date it is a little in advance of the present chapter.

TO MRS. HOLBROOK.

CAMBRIDGE, *July*, 1852.

. . . I am again working at the human races, and have opened another line of investigation in that direction. The method followed by former investigators does not seem to me to have been altogether the best, since there is so little agreement between them. The difficulty has, no doubt, arisen on one side from the circumstance that the inquirer sought for evidence of the unity of all races, expecting the result to agree with the prevailing interpretation of Genesis; and on the other from too zoölogical a point of view in weighing the differences observed. Again, both have almost set aside all evidence not directly derived from the examination of the

races themselves. It has occurred to me that as a preliminary inquiry we ought to consider the propriety of applying to man the same rules as to animals, examining the limits within which they obtain, and paying due attention to all circumstances bearing upon the differences observed among men, from whatever quarter in the study of nature they may be gathered. What do the monkeys say to this? or, rather, what have they to tell in reference to it? There are among them as great, and, indeed, even greater, differences than among men, for they are acknowledged to constitute different genera, and are referred to many, indeed to more than a hundred, species; but they are the nearest approach to the human family, and we may at least derive some hints from them. How much mixture there is among these species, if any, is not at all ascertained; indeed, we have not the least information respecting their intercourse; but one point is certain, — zoölogists agree as little among themselves respecting the limits of these species as they do respecting the affinities of the races of men. What some consider as distinct species, others consider as mere varieties, and these varieties or species differ in particulars neither more constant nor more

important than those which distinguish the human races. The fact that they are arranged in different genera, species, and varieties does not lessen the value of the comparison; for the point in question is just to know whether nations, races, and what have also been called families of men, such as the Indo-Germanic, the Semitic, etc., do not in reality correspond to the families, genera, and species of monkeys. Now the first great subdivisions among the true monkeys (excluding Makis and Arctopitheci) are founded upon the form of the nose, those of the new world having a broad partition between the nostrils, while those of the old world have it narrow. How curious that this fact, which has been known to naturalists for half a century, as presenting a leading feature among monkeys, should have been overlooked in man, when, in reality, the negroes and Australians differ in precisely the same manner from the other races; they having a broad partition, and nostrils opening sideways, like the monkeys of South America, while the other types of the human family have a narrow partition and nostrils opening downward, like the monkeys of Asia and Africa. Again, the minor differences, such as the obliquity of the anterior

teeth, the thickness of the lips, the projection of the cheek-bones, the position of the eyes, the characteristic hair, or wool, afford as constant differences as those by which the chimpanzees, orangs, and gibbons are separated into distinct genera; and their respective species differ no more than do the Greeks, Germans, and Arabs, — or the Chinese, Tartars, and Finns, — or the New Zealanders and Malays, which are respectively referred to the same race. The truth is, that the different *species* admitted by some among the orangs are in reality *races* among monkeys, or else the races among men are nothing more than what are called species among certain monkeys. . . . Listen for a moment to the following facts, and when you read this place a map of the world before you. Upon a narrow strip of land along the Gulf of Guinea, from Cape Palmas to the Gaboon, live two so-called species of chimpanzee; upon the islands of Sumatra and Borneo live three or four orangs; upon the shores of the Gulf of Bengal, including the neighborhood of Calcutta, Burmah, Malacca, Sumatra, Borneo, and Java together, ten or eleven species of gibbons, all of which are the nearest relatives to the human family, some being as large as

certain races of men; altogether, fifteen species of anthropoid monkeys playing their part in the animal population of the world upon an area not equaling by any means the surface of Europe. Some of these species are limited to Borneo, others to Sumatra, others to Java alone, others to the peninsula of Malacca; that is to say to tracts of land similar in extent to Spain, France, Italy, and even to Ireland; distinct animals, considered by most naturalists as distinct species, approaching man most closely in structural eminence and size, limited to areas not larger than Spain or Italy. Why, then, should not the primitive theatre of a nation of men have been circumscribed within similar boundaries, and from the beginning have been as independent as the chimpanzee of Guinea, or the orangs of Borneo and Sumatra? Of course, the superior powers of man have enabled him to undertake migrations, but how limited are these, and how slight the traces they have left behind them. . . . Unfortunately for natural history, history so-called has recorded more faithfully the doings of handfuls of adventurers than the real history of the primitive nations with whom the migrating tribes came into contact. But I hope it will yet be pos-

sible to dive under these waves of migration, to remove, as it were, the trace of their passage, and to read the true history of the past inhabitants of the different parts of the world, when it will be found, if all analogies are not deceptive, that every country equaling in extent those within the limits of which distinct nationalities are known to have played their part in history, has had its distinct aborigines, the character of which it is now the duty of naturalists to restore, if it be not too late, in the same manner as paleontologists restore fossil remains. I have already made some attempts, by studying ancient geography, and I hope the task may yet be accomplished. Look, for instance, at Spain. The Iberians are known as the first inhabitants, never extending much beyond the Pyrenees to the Garonne, and along the gulfs of Lyons and Genoa. As early as during the period of Phœnician prosperity they raised wool from their native sheep, derived from the Mouflon, still found wild in Spain, Corsica, and Sardinia; they had a peculiar breed of horses, to this day differing from all other horses in the world. Is this not better evidence of their independent origin, than is the fancied lineage with the Indo-Germanic family of their

Oriental descent? For we must not forget, in connection with this, that the Basque language was once the language of all Spain, that which the Iberian spoke, and which has no direct relation to Sanskrit.

I have alluded but slightly to the negro race, and not at all to the Indians. I would only add with reference to these that I begin to perceive the possibility of distinguishing different centres of growth in these two continents. If we leave out of consideration fancied migrations, what connection can be traced, for instance, between the Eskimos, along the whole northern districts of this continent, and the Indians of the United States, those of Mexico, those of Peru, and those of Brazil? Is there any real connection between the coast tribes of the northwest coast, the mound builders, the Aztec civilization, the Inca, and the Gueranis? It seems to me no more than between the Assyrian and Egyptian civilization. And as to negroes, there is, perhaps, a still greater difference between those of Senegal, of Guinea, and the Caffres and Hottentots, when compared with the Gallahs and Mandingoes. But where is the time to be taken for the necessary investigations involved in these inquiries? Pray write to

me soon what you say to all this, and believe me always your true friend,

L. Agassiz.

In the spring of 1852, while still in Charleston, Agassiz heard that the Prix Cuvier, now given for the first time, was awarded to him for the "Poissons Fossiles." This gratified him the more because the work had been so directly bequeathed to him by Cuvier himself. To his mother, through whom he received the news in advance of the official papers, it also gave great pleasure. "Your fossil fishes," she says, "which have cost you so much anxiety, so much toil, so many sacrifices, have now been estimated at their true value by the most eminent judges. . . . This has given me such happiness, dear Louis, that the tears are in my eyes as I write it to you." She had followed the difficulties of his task too closely not to share also its success.

CHAPTER XVII.

1852–1855: ÆT. 45–48.

Return to Cambridge. — Anxiety about Collections. — Purchase of Collections. — Second Winter in Charleston. — Illness. — Letter to James D. Dana concerning Geographical Distribution and Geological Succession of Animals. — Resignation of Charleston Professorship. — Propositions from Zurich. — Letter to Oswald Heer. — Decision to remain in Cambridge. — Letters to James D. Dana, S. S. Haldeman, and Others respecting Collections illustrative of the Distribution of Fishes, Shells, etc., in Our Rivers. — Establishment of Schools for Girls.

Agassiz returned from Charleston to Cambridge in the early spring, pausing in Washington to deliver a course of lectures before the Smithsonian Institution. By this time he had become intimate with Professor Henry, at whose hospitable house he and his family were staying during their visit at Washington. He had the warmest sympathy not only with Professor Henry's scientific work and character, but also with his views regarding the Smithsonian Institution, of which he had become the Superintendent shortly after Agassiz arrived in this country. Agassiz himself was soon appointed one of the Regents of the

Institution and remained upon the Board until his death.

Agassiz now began to feel an increased anxiety about his collections. During the six years of his stay in the United States he had explored the whole Atlantic sea-board as well as the lake and river system of the Eastern and Middle States, and had amassed such materials in natural history as already gave his collections, in certain departments at least, a marked importance. In the lower animals, and as illustrating the embryology of the marine invertebrates, they were especially valuable. It had long been a favorite idea with him to build up an embryological department in his prospective museum; the more so because such a provision on any large scale had never been included in the plan of the great zoölogical institutions, and he believed it would have a direct and powerful influence on the progress of modern science. The collections now in his possession included ample means for this kind of research, beside a fair representation of almost all classes of the animal kingdom. Packed together, however, in the narrowest quarters, they were hardly within his own reach, much less could they be made available for others. His own resources

were strained to the utmost, merely to save these precious materials from destruction. It is true that in 1850 the sum of four hundred dollars, to be renewed annually, was allowed him by the University for their preservation, and a barrack-like wooden building on the college grounds, far preferable to the bath-house by the river, was provided for their storage. But the cost of keeping them was counted by thousands, not by hundreds, and the greater part of what Agassiz could make by his lectures outside of Cambridge was swallowed up in this way. It was, perhaps, the knowledge of this which induced certain friends, interested in him and in science, to subscribe twelve thousand dollars for the purchase of his collections, to be thus permanently secured to Cambridge. This gave him back, in part, the sum he had already spent upon them, and which he was more than ready to spend again in their maintenance and increase.

The next year showed that his over-burdened life was beginning to tell upon his health. Scarcely had he arrived in Charleston and begun his course at the Medical College when he was attacked by a violent fever, and his life was in danger for many days. Fortu-

nately for him his illness occurred at the "Hollow Tree," where he was passing the Christmas holidays. Dr. and Mrs. Holbrook were like a brother and sister to him, and nothing could exceed the kindness he received under their roof. One young friend who had been his pupil, and to whom he was much attached, Dr. St. Julian Ravenel, was constantly at his bedside. His care was invaluable, for he combined the qualities of physician and nurse. Under such watchful tending, Agassiz could hardly fail to mend if cure were humanly possible. The solicitude of these nearer friends seemed to be shared by the whole community, and his recovery gave general relief. He was able to resume his lectures toward the end of February. Spite of the languor of convalescence his elastic mind was at once ready for work, as may be seen by the following extract from one of his first letters.

TO JAMES D. DANA.

SULLIVAN'S ISLAND, CHARLESTON,
February 16, 1853.

. . . It seems, indeed, to me as if in the study of the geographical distribution of animals the present condition of the animal kingdom was too exclusively taken into considera-

tion. Whenever it can be done, and I hope before long it may be done for all classes, it will be desirable to take into account the relations of the living to the fossil species. Since you are as fully satisfied as I am that the location of animals, with all their peculiarities, is not the result of physical influences, but lies within the plans and intentions of the Creator, it must be obvious that the successive introduction of all the diversity of forms which have existed from the first appearance of any given division of the animal kingdom up to the present creation, must have reference to the location of those now in existence. For instance, if it be true among mammalia that the highest types, such as quadrumana, are essentially tropical, may it not be that the prevailing distribution of the inferior pachyderms within the same geographical limits is owing to the circumstance that their type was introduced upon earth during a warmer period in the history of our globe, and that their present location is in accordance with that fact, rather than related to their degree of organization? The pentacrinites, the lowest of the echinoderms, have only one living representative in tropical America, where we find at the same time the highest and largest

spatangi and holothuridæ. Is this not quite a parallel case with the monkeys and pachyderms? for once crinoids were the only representatives of the class of echinoderms. May we not say the same of crocodiles when compared with the ancient gigantic saurians? or are the crocodiles, as an order, distinct from the other saurians, and really higher than the turtles? Innumerable questions of this kind, of great importance for zoölogy, are suggested at every step, as soon as we compare the present distribution of animals with that of the inhabitants of former geological periods. Among crustacea, it is very remarkable that trilobites and limulus-like forms are the only representatives of the class during the paleozoic ages; that macrourans prevailed in the same manner during the secondary period; and that brachyurans make their appearance only in the tertiary period. Do you discover in your results any connection between such facts and the present distribution of crustacea? There is certainly one feature in their classification which must appear very striking, — that, taken on a large scale, the organic rank of these animals agrees in the main with their order of succession in geological times; and this fact is of no small

importance when it is found that the same correspondence between rank and succession obtains through all classes of the animal kingdom, and that similar features are displayed in the embryonic growth of all types so far as now known.

But I feel my head is growing dull, and I will stop here. Let me conclude by congratulating you on having completed your great work on crustacea. . . .

Agassiz returned to the North in the spring of 1853 by way of the Mississippi, stopping to lecture at Mobile, New Orleans, and St. Louis. On leaving Charleston he proffered his resignation with deep regret, for, beside the close personal ties he had formed, he was attached to the place, the people, and to his work there. He had hoped to establish a permanent station for sustained observations in South Carolina, and thus to carry on a series of researches which, taken in connection with his studies on the New England coast and its vicinity, and on the Florida reefs and shores, would afford a wide field of comparison. This was not to be, however. The Medical College refused, indeed, to accept his resignation, granting him, at the same time, a year of

absence. But it soon became evident that his health was seriously shaken, and that he needed the tonic of the northern winter. He was, indeed, never afterward as strong as he had been before this illness.

The winter of 1854 was passed in Cambridge with such quiet and rest as the conditions of his life would allow. In May of that year he received an invitation to the recently established University of Zurich, in Switzerland. His acceptance was urged upon the ground of patriotism as well as on that of a liberal endowment both for the professor, and for the museum of which he was to have charge. The offer was tempting, but Agassiz was in love (the word is not too strong) with the work he had undertaken and the hopes he had formed in America. He believed that by his own efforts, combined with the enthusiasm for science which he had aroused and constantly strove to keep alive and foster in the community, he should at last succeed in founding a museum after his own heart in the United States, — a museum which should not be a mere accumulation, however vast or extensive, of objects of natural history, but should have a well-combined and clearly expressed educational value. As we

shall see, neither the associations of his early life nor the most tempting scientific prizes in the gift of the old world could divert him from this settled purpose. The proposition from Zurich was not official, but came through a friend and colleague, for whom he had the deepest sympathy and admiration, — Oswald Heer. To work in his immediate neighborhood would have been in itself a temptation.

TO PROFESSOR OSWALD HEER.

CAMBRIDGE, *January* 9, 1855.

MY HONORED FRIEND, — How shall I make you understand why your kind letter, though it reached me some months ago, has remained till now unanswered. It concerns a decision of vital importance to my whole life, and in such a case one must not decide hastily, nor even with too exclusive regard for one's own preference in the matter. You cannot doubt that the thought of joining an institution of my native country, and thus helping to stimulate scientific progress in the land of my birth, my home, and my early friends, appeals to all I hold dear and honorable in life. On the other side I have now been eight years in America, have learned to understand the advantages of my position here, and have begun undertak-

ings which are not yet brought to a conclusion. I am aware also how wide an influence I already exert upon this land of the future, — an influence which gains in extent and intensity with every year, — so that it becomes very difficult for me to discern clearly where I can be most useful to science. Among my privileges I must not overlook that of passing much of my time on the immediate sea-shore, where the resources for the zoölogist and embryologist are inexhaustible. I have now a house distant only a few steps from an admirable locality for these studies, and can therefore pursue them uninterruptedly throughout the whole year, instead of being limited, like most naturalists, to the short summer vacations. It is true I miss the larger museums, libraries, etc., as well as the stimulus to be derived from association with a number of like-minded co-workers, all striving toward the same end. With every year, however, the number of able and influential investigators increases here, and among them are some who might justly claim a prominent place anywhere. . . .

Neither are means for publication lacking. The larger treatises with costly illustrations appear in the Smithsonian Contributions, in the

Transactions of the American Philosophical Society, in those of the Academy of Natural Sciences, and in the Memoirs of the American Academy; while the smaller communications find a place in Silliman's Journal, in the Journal of the Boston Natural History Society, and in the proceedings of other scientific societies. Museums also are already founded; . . . and beside these there are a number of private collections in single departments of zoölogy. . . . Better than all this, however, is the lively and general interest taken in the exploration of the country itself. Every scientific expedition sent out by the government to the interior, or to the Western States of Oregon and California, is accompanied by a scientific commission, — zoölogists, geologists, and botanists. By this means magnificent collections, awaiting only able investigators to work them up, have been brought together. Indeed, I do not believe that as many new things are accumulated anywhere as just here, and it is my hope to contribute hereafter to the more critical and careful examination of these treasures. Under these circumstances I have asked myself for months past how I ought to decide; not what were my inclinations, for that is not the question, — but what

was my duty toward science? After the most careful consideration I am no longer in doubt, and though it grieves me to do so, I write to beg that you will withdraw from any action which might bring me a direct call to the professorship in Zurich. I have decided to remain here for an indefinite time, under the conviction that I shall exert a more advantageous and more extensive influence on the progress of science in this country than in Europe.

I regret that I cannot accept your offer of the Oeningen fossils. In the last two years I have spent more than 20,000 francs on my collection, and must not incur any farther expense of that kind at present. As soon, however, as I have new means at my command such a collection would be most welcome, and should it remain in your hands I may be very glad to take it. Neither can I make any exchange of duplicates just now, as I have not yet been able to sort my collections and set aside the specimens which may be considered only as materials for exchange. Can you procure for me Glarus fishes in any considerable number? I should like to purchase them for my collection, and do not care for single specimens of every species, but would prefer

whole suites that I may revise my former identifications in the light of a larger insight.

Remember me kindly to all my Zurich friends, and especially to C. Escher. . . .

His ever-increasing and at last wholly unmanageable correspondence attests the general sympathy for and coöperation with his scientific aims in the United States. In 1853, for instance, he had issued a circular, asking for collections of fishes from various fresh-water systems of the United States, in order that he might obtain certain data respecting the laws of their distribution and localization. To this he had hundreds of answers coming from all parts of the country, many of them very shrewd and observing, giving facts respecting the habits of fishes, as well as concerning their habitat, and offering aid in the general object. Nor were these empty promises. A great number and variety of collections, now making part of the ichthyological treasures of the Museum at Cambridge, were forwarded to him in answer to this appeal. Indeed, he now began to reap, in a new form, the harvest of his wandering lecture tours. In this part of his American experience he had come into contact with all classes of people, and had found

some of his most intelligent and sympathetic listeners in the working class. Now that he needed their assistance he often found his co-laborers among farmers, stock-raisers, sea-faring men, fishermen, and sailors. Many a New England captain, when he started on a cruise, had on board collecting cans, furnished by Agassiz, to be filled in distant ports or nearer home, as the case might be, and returned to the Museum at Cambridge. One or two letters, written to scientific friends at the time the above-mentioned circular was issued, will give an idea of the way in which Agassiz laid out such investigations.

TO JAMES D. DANA.

CAMBRIDGE, *July* 8, 1853.

. . . I have been lately devising some method of learning how far animals are truly autochthones, and how far they have extended their primitive boundaries. I will attempt to test that question with Long Island, the largest of all the islands along our coast. For this purpose I will for the present limit myself to the fresh-water fishes and shells, and for the sake of comparison I will try to collect carefully all the species living in the rivers of Connecticut, New York, and New Jersey, and

see whether they are identical with those of the island. Whatever may come out of such an investigation it will, at all events, furnish interesting data upon the local distribution of the species. . . . I am almost confident that it will lead to something interesting, for there is one feature of importance in the case; the present surface of Long Island is not older than the drift period; all its inhabitants must, therefore, have been introduced since that time. I shall see that I obtain similar collections from the upper course of the Connecticut, so as to ascertain whether there, as in the Mississippi, the species differ at different heights of the river basin. . . .

TO PROFESSOR S. S. HALDEMAN, COLUMBIA, PENNSYLVANIA.

CAMBRIDGE, *July* 9, 1853.

. . . While ascending the great Mississippi last spring I was struck with the remarkable fact that the fishes differ essentially in the different parts of that long water-course, — a fact I had already noticed in the Rhine, Rhone, and Danube, though there the difference arises chiefly from the occurrence, in the higher Alpine regions, of representatives of the trout family which are not found in the

main river course. In the Mississippi, however, the case is otherwise and very striking, inasmuch as we find here, at separate latitudes, distinct species of the same genera, somewhat like the differences observed in distinct water-basins; and yet the river is ever flowing on past these animals, which remain, as it were, spell-bound to the regions most genial to them. The question at once arises, do our smaller rivers present similar differences? I have already taken steps to obtain complete collections of fishes, shells, and crayfishes from various stations on the Connecticut and the Hudson, and their tributaries; and I should be very happy if I could include the Susquehanna, Delaware, and Ohio in my comparisons. My object in writing now is to inquire whether you could assist me in making separate collections, as complete as possible, of all these animals from the north and west branches of the Susquehanna, from the main river either at Harrisburg or Columbia, and from the Juniata, also from the Schuylkill, Lehigh, and Delaware, and from the Alleghany and Monongahela. I have Swiss friends in the State of New York who have promised me to collect the fishes from the head-waters of the Delaware and Susque-

hanna within the limits of the State of New York. I cannot, of course, expect you to survey your State for me, but among your acquaintance in various parts of your State are there not those who, with proper directions, could do the work for me? I would, of course, gladly repay all their expenses. The subject seems to me so important as to justify any effort in that direction. Little may be added to the knowledge of the fishes themselves, for I suppose most of the species have been described either by De Kay, Kirtland, or Storer; but a careful study of their special geographical distribution may furnish results as important to zoölogy as the knowledge of the species themselves. If you cannot write yourself, will you give me the names of such persons as might be persuaded to aid in the matter. I know from your own observations in former times that you have already collected similar facts for the Unios, so that you will at once understand and appreciate my object. . . .

He writes in the same strain and for the same object to Professor Yandell, of Kentucky, adding: "In this respect the State of Kentucky is one of the most important of the

Union, not only on account of the many rivers which pass through its territory, but also because it is one of the few States the fishes of which have been described by former observers, especially by Rafinesque in his "Ichthyologia Ohioensis," so that a special knowledge of all his original types is a matter of primary importance for any one who would compare the fishes of the different rivers of the West. . . . Do you know whether there is anything left of Rafinesque's collection of fishes in Lexington, and if so, whether the specimens are labeled, as it would be very important to identify his species from his own collection and his own labels? I never regretted more than now that circumstances have not yet allowed me to visit your State and make a stay in Louisville."

In 1854 Agassiz moved to a larger house, built for him by the college. Though very simple, it was on a liberal scale with respect to space; partly in order to accommodate his library, consisting of several thousand volumes, now for the first time collected and arranged in one room. He became very fond of this Cambridge home, where, with few absences, he spent the remainder of his life. The architect, Mr. Henry Greenough, was his

personal friend, and from the beginning the house adapted itself with a kindly readiness to whatever plans developed under its roof. As will be seen, these were not few, and were sometimes of considerable moment. For his work also the house was extremely convenient. His habits in this respect were, however, singularly independent of place and circumstance. Unlike most studious men, he had no fixed spot in the house for writing. Although the library, with the usual outfit of well-filled shelves, maps, large tables, etc., held his materials, he brought what he needed for the evening by preference to the drawing-room, and there, with his paper on his knee, and his books for reference on a chair beside him, he wrote and read as busily as if he were quite alone. Sometimes when dancing and music were going on among the young people of the family and their guests, he drew a little table into the corner of the room, and continued his occupations as undisturbed and engrossed as if he had been in complete solitude, — only looking up from time to time with a pleased smile or an apt remark, which showed that he did not lose but rather enjoyed what was going on about him.

His children's friends were his friends. As

his daughters grew up, he had the habit of inviting their more intimate companions to his library for an afternoon weekly. On these occasions there was always some subject connected with the study of nature under discussion, but the talk was so easy and so fully illustrated that it did not seem like a lesson. The daughters of Mr. Ralph Waldo Emerson were members of this class, and it is pleasant to remember that in later years he revived the custom, and their friends (being, indeed, the same set of young people as had formerly met in Agassiz's library) used to meet in Mr. Emerson's study at Concord for a similar object. He talked to them of poetry and literature and philosophy as Agassiz had talked to them of nature. Those were golden days, not to be forgotten by any who shared their happy privilege.

In the winter of 1855 Agassiz endeavored to resume his public lectures as a means of increasing his resources. He was again, however, much exhausted when spring came, and it seemed necessary to seek some other means of support, for without considering scientific expenses, his salary of fifteen hundred dollars did not suffice for the maintenance of his family. Under these circumstances it occurred

to his wife and his two older children, now of an age to assist her in such a scheme, that a school for young ladies might be established in the upper part of the new and larger house. By the removal of one or two partitions, ample room could be obtained for the accommodation of a sufficient number of pupils, and if successful such a school would perhaps make good in a pecuniary sense the lecturing tours which were not only a great fatigue to Agassiz, but an interruption also to all consecutive scientific work. In consultation with friends these plans were partly matured before they were confided to Agassiz himself. When the domestic conspirators revealed their plot, his surprise and pleasure knew no bounds. The first idea had been simply to establish a private school on the usual plan, only referring to his greater experience for advice and direction in its general organization. But he claimed at once an active share in the work. Under his inspiring influence the outline enlarged, and when the circular announcing the school was issued, it appeared under his name, and contained these words in addition to the programme of studies: "I shall myself superintend the methods of instruction and tuition, and while maintaining that regularity

and precision in the studies so important to mental training shall endeavor to prevent the necessary discipline from falling into a lifeless routine, alike deadening to the spirit of teacher and pupil. It is farther my intention to take the immediate charge of the instruction in Physical Geography, Natural History, and Botany, giving a lecture daily, Saturdays excepted, on one or other of these subjects, illustrated by specimens, models, maps, and drawings."

In order not to interrupt the course of the narrative, the history of this undertaking in its sequence and general bearing on his life and work may be completed here in a few words. This school secured to him many happy and comparatively tranquil years. It enabled him to meet both domestic and scientific expenses, and to pay the heavy debt he had brought from Europe as the penalty of his "Fossil Fishes" and his investigations on the glaciers. When the school closed after eight years he was again a free man. With an increased salary from the college, and with such provision for the Museum (thanks to the generosity of the State and of individuals) as rendered it in a great degree independent, he was never again involved in the pecuniary

anxieties of his earlier career. The occupation of teaching was so congenial to him that his part in the instruction of the school did not at any time weigh heavily upon him. He never had an audience more responsive and more eager to learn than the sixty or seventy girls who gathered every day at the close of the morning to hear his daily lecture; nor did he ever give to any audience lectures more carefully prepared, more comprehensive in their range of subjects, more lofty in their tone of thought. As a teacher he always discriminated between the special student, and the one to whom he cared to impart only such a knowledge of the facts of nature, as would make the world at least partially intelligible to him. To a school of young girls he did not think of teaching technical science, and yet the subjects of his lectures comprised very abstruse and comprehensive questions. It was the simplicity and clearness of his method which made them so interesting to his young listeners. "What I wish for you," he would say, "is a culture that is alive, active, susceptible of farther development. Do not think that I care to teach you this or the other special science. My instruction is only intended to show you the thoughts in nature which

science reveals, and the facts I give you are useful only, or chiefly, for this object."

Running over the titles of his courses during several consecutive years of this school instruction they read: Physical Geography and Paleontology; Zoölogy; Botany; Coral Reefs; Glaciers; Structure and Formation of Mountains; Geographical Distribution of Animals; Geological Succession of Animals; Growth and Development of Animals; Philosophy of Nature, etc. With the help of drawings, maps, bas-reliefs, specimens, and countless illustrations on the blackboard, these subjects were made clear to the pupils, and the lecture hour was anticipated as the brightest of the whole morning. It soon became a habit with friends and neighbors, and especially with the mothers of the scholars, to drop in for the lectures, and thus the school audience was increased by a small circle of older listeners. The corps of teachers was also gradually enlarged. The neighborhood of the university was a great advantage in this respect, and Agassiz had the coöperation not only of his brother-in-law, Professor Felton, but of others among his colleagues, who took classes in special departments, or gave lectures in history and literature.

This school opened in 1855 and closed in 1863. The civil war then engrossed all thoughts, and interfered somewhat also with the success of private undertakings. Partly on this account, partly also because it had ceased to be a pecuniary necessity, it seemed wise to give up the school at this time. The friendly relations formed there did not, however, cease with it. For years afterward on the last Thursday of June (the day of the annual closing of the school) a meeting of the old pupils was held at the Museum, which did not exist when the school began, but was fully established before its close. There Agassiz showed them the progress of his scientific work, told them of his future plans for the institution, and closed with a lecture such as he used to give them in their school-days. The last of these meetings took place in 1873, the last year of his own life. The memory of it is connected with a gift to the Museum of four thousand and fifty dollars from a number of the scholars, now no longer girls, but women with their own cares and responsibilities. Hearing that there was especial need of means for the care of the more recent collections, they had subscribed this sum among themselves to express their affection for their

old teacher, as well as their interest in his work, and in the institution he had founded. His letter of acknowledgment to the one among them who had acted as their treasurer makes a fitting close to this chapter.

. . . Hardly anything in my life has touched me more deeply than the gift I received this week from my school-girls. From no source in the world could sympathy be more genial to me. The money I shall appropriate to a long-cherished scheme of mine, a special work in the Museum which must be exclusively my own, — the arrangement of a special collection illustrating in a nutshell, as it were, all the relations existing among animals, — which I have deferred because other things were more pressing, and our means have been insufficient. The feeling that you are all working with me will be even more cheering than the material help, much needed as that is. I wish I could write to each individually. I shall try to find some means of expressing my thanks more widely. Meantime I write to you as treasurer, and beg you, as far as you can do so without too much trouble, to express my gratitude to others. Will you also say to those whom you chance to meet that I shall be at

the Museum on the last Thursday of June, at half-past eleven o'clock. I shall be delighted to see all to whom it is convenient to come. The Museum has grown not only in magnitude, but in scientific significance, and I like from time to time to give you an account of its progress, and of my own work and aims. How much thought and care and effort this kind plan of yours must have involved, scattered as you all are! It cannot have been easy to collect the names and addresses of all those whose signatures it was delightful to me to see again. Words seem to me very poor, but you will accept for yourself and your school-mates the warm thanks and affectionate regards of your old friend and teacher.

L. R. AGASSIZ.

CHAPTER XVIII.

1855–1860 : ÆT. 48–53.

"Contributions to Natural History of the United States." — Remarkable Subscription. — Review of the Work. — Its Reception in Europe and America. — Letters from Humboldt and Owen concerning it. — Birthday. — Longfellow's Verses. — Laboratory at Nahant. — Invitation to the Museum of Natural History in Paris. — Founding of Museum of Comparative Zoölogy in Cambridge. — Summer Vacation in Europe.

A FEW months earlier than the school circular Agassiz issued another prospectus, which had an even more important bearing upon his future work. This was the prospectus for his "Contributions to the Natural History of the United States." It was originally planned in ten volumes, every volume to be, however, absolutely independent, so that the completeness of each part should not be impaired by any possible interruption of the sequence. The mass of original material accumulated upon his hands ever since his arrival in America made such a publication almost imperative, but the costliness of a large illustrated work

deterred him. The "Poissons Fossiles" had shown him the peril of entering upon such an enterprise without capital. Perhaps he would never have dared to undertake it but for a friendly suggestion which opened a way out of his perplexities. Mr. Francis C. Gray, of Boston, who felt not only the interest of a personal friend in the matter, but also that of one who was himself a lover of letters and science, proposed an appeal to the public spirit of the country in behalf of a work devoted entirely to the Natural History of the United States. Mr. Gray assumed the direction of the business details, set the subscription afloat, stimulated its success by his own liberal contributions, by letters, by private and public appeals. The result far exceeded the most sanguine expectations of those interested in its success. Indeed, considering the purely scientific character of the work, the number of subscribers for it was extraordinary, and showed again the hold Agassiz had taken upon the minds and affections of the people in general. The contributors were by no means confined to Boston and Cambridge, although the Massachusetts list was naturally the largest, nor were they found exclusively among literary and scientific circles. On the contrary,

the subscription list, to the astonishment of the publishers, was increased daily by unsolicited names, sent in from all sections of the country, and from various grades of life and occupation. In reference to the character of this subscription Agassiz says in his Preface: "I must beg my European readers to remember that this work is written in America, and more especially for Americans; and that the community to which it is particularly addressed has very different wants from those of the reading public in Europe. There is not a class of learned men here distinct from the other cultivated members of the community. On the contrary, so general is the desire for knowledge, that I expect to see my book read by operatives, by fishermen, by farmers, quite as extensively as by the students in our colleges or by the learned professions, and it is but proper that I should endeavor to make myself understood by all." If Agassiz, perhaps, overestimated in this statement the appreciation of the reading public in the United States for pure scientific research, it was because the number and variety of his subscribers gave evidence of a cordiality toward his work which surprised as much as it gratified him. On the list there were also some of his old European

subscribers to the "Poissons Fossiles," among them the King of Prussia, who still continued, under the influence of Humboldt, to feel an interest in his work.

FROM HUMBOLDT TO AGASSIZ.

September 1, 1856.

. . . I hear that by some untoward circumstances, no doubt accidental, you have never received, my dear Agassiz, the letter expressing the pleasure which I share with all true lovers of science respecting your important undertaking, "Contributions to the Natural History of the United States." You must have been astonished at my silence, remembering, not only the affectionate relations we have held to each other ever since your first sojourn at Paris, but also the admiration I have never ceased to feel for the great and solid works which we owe to your sagacious mind and your incomparable intellectual energy. . . . I approve especially the general conceptions which lie at the base of the plan you have traced. I admire the long series of physiological investigations, beginning with the embryology of the so-called simple and lower organisms and ascending by degrees to the more complicated. I admire that ever-renewed

comparison of the types belonging to our planet, in its present condition, with those now found only in a fossil state, so abundant in the immense space lying between the shores opposite to northern Europe and northern Asia. The geographical distribution of organic forms in curves of equal density of occupation represents in great degree the inflexions of the isothermal lines. . . . I am charged by the king, who knows the value of your older works, and who still feels for you the affectionate regard which he formerly expressed in person, to request that you will place his name at the head of your long list of subscribers. He wishes that an excursion across the Atlantic valley may one day bring you, who have so courageously braved Alpine summits, to the historic hill of Sans Souci. . . .

Something of Agassiz's astonishment and pleasure at the encouragement given to his projected work is told in his letters. To his old friend Professor Valenciennes, in Paris, he writes: "I have just had an evidence of what one may do here in the interest of science. Some six months ago I formed a plan for the publication of my researches in America, and determined to carry it out with all

possible care and beauty of finish. I estimated my materials at ten volumes, quarto, and having fixed the price at 60 francs ($12.00) a volume, thought I might, perhaps, dispose of five hundred. I brought out my prospectus, and I have to-day seventeen hundred subscribers. What do you say to that for a work which is to cost six hundred francs a copy, and of which nothing has as yet appeared? Nor is the list closed yet, for every day I receive new subscriptions, — this very morning one from California! Where will not the love of science find its niche!" . . .

In the same strain he says, at a little later date, to Sir Charles Lyell: "You will, no doubt, be pleased to learn that the first volume of my new work, 'Contributions to the Natural History of the United States,' which is to consist of ten volumes, quarto, is now printing, to come out this summer. I hope it will show that I have not been idle during ten years' silence. I am somewhat anxious about the reception of my first chapter, headed, 'Classification,' which contains anything but what zoölogists would generally expect under that head. The subscription is marvelous. Conceive twenty-one hundred names before the appearance of the first pages of a work

costing one hundred and twenty dollars! It places in my hands the means of doing henceforth for Natural History what I had never dreamed of before." . . .

This work, as originally planned, was never completed. It was cut short by ill-health and by the pressure of engagements arising from the rapid development of the great Museum, which finally became, as will be seen, the absorbing interest of his life. As it stands, the "Contributions to the Natural History of the United States" consists of four large quarto volumes. The first two are divided into three parts, namely: 1st. An Essay on Classification. 2d. The North American Testudinata. 3d. The Embryology of the Turtle, — the latter two being illustrated by thirty-four plates. The third and fourth volumes are devoted to the Radiata, and consist of five parts, namely: 1st. Acalephs in general. 2d. Ctenophoræ. 3d. Discophoræ. 4th. Hydroida. 5th. Homologies of the Radiates, — illustrated by forty-six plates.[1]

[1] The plates are of rare accuracy and beauty, and were chiefly drawn by A. Sonrel, though many of the microscopic drawings were made by Professor H. J. Clark, who was at that time Agassiz's private assistant. For details respecting Professor Clark's share in this work, and also concerning the aid of various kinds furnished to the author during its prep-

For originality of material, clearness of presentation, and beauty of illustration, these volumes have had their full recognition as models of scientific work. Their philosophy was, perhaps, too much out of harmony with the current theories of the day to be acceptable. In the "Essay on Classification" especially, Agassiz brought out with renewed earnestness his conviction that the animal world rests upon certain abstract conceptions, persistent and indestructible. He insists that while physical influences maintain, and within certain limits modify, organisms, they have never affected typical structure, — those characters, namely, upon which the great groups of the animal kingdom are united. From his point of view, therefore, what environment can do serves to emphasize what it cannot do. For the argument on which these conclusions are based we refer to the book itself. The discussion of this question occupies, however, only the first portion of the volume, two thirds of which are devoted to a general consideration of classification, and the ideas which it embodies, with a review of the modern systems of zoölogy.

aration, the reader is referred to the Preface of the volumes themselves.

The following letter was one of many in the same tone received from his European correspondents concerning this work.

FROM RICHARD OWEN.

December 9, 1857.

. . . I cannot permit a day to elapse without thanking you for the two volumes of your great work on American zoölogy, which, from your masterly and exhaustive style of treatment, becomes the most important contribution to the right progress of zoölogical science in all parts of the world where progress permits its cultivation. It is worthy of the author of the classical work on fossil fishes; and such works, like the Cyclopean structures of antiquity, are built to endure. I feel and I beg to express a fervent hope that you may be spared in health and vigor to see the completion of your great plan.

I have placed in Mr. Trübner's hands a set of the numbers (6) of my "History of British Fossil Reptiles," which have already appeared; a seventh will soon be out, and as they will be sent to you in succession I hope you will permit me to make a small and inadequate return for your liberality in the gift of your work

by adding your name to the list of my subscribers. . . .

Believe me always truly yours,

RICHARD OWEN.

Agassiz had promised himself that the first volume of his new work should be finished in time for his fiftieth birthday, — a milestone along the road, as it were, to mark his half century. Upon this self-appointed task he spent himself with the passion dominated by patience, which characterized him when his whole heart was bent toward an end. For weeks he wrote many hours of the day and a great part of the night, going out sometimes into the darkness and the open air to cool the fever of work, and then returning to his desk again. He felt himself that the excitement was too great, and in proportion to the strain was the relief when he set the seal of *finis* on his last page within the appointed time.

His special students, young men who fully shared his scientific life and rewarded his generosity by an affectionate devotion, knowing, perhaps, that he himself associated the completion of his book with his birthday, celebrated both events by a serenade on the eve of his anniversary. They took into their con-

fidence Mr. Otto Dresel, warmly valued by Agassiz both as friend and musician, and he arranged their midnight programme for them. Always sure of finding their professor awake and at work at that hour, they stationed the musicians before the house, and as the last stroke of twelve sounded, the succeeding stillness was broken by men's voices singing a Bach choral. When Agassiz stepped out to see whence came this pleasant salutation, he was met by his young friends bringing flowers and congratulations. Then followed one number after another of the well-ordered selection, into which was admitted here and there a German student song in memory of Agassiz's own university life at Heidelberg and Munich. It was late, or rather early, since the new day was already begun, before the little concert was over and the guests had dispersed. It is difficult to reproduce with anything like its original glow and coloring a scene of this kind. It will no more be called back than the hour or the moonlight night which had the warmth and softness of June. It is recorded here only because it illustrates the intimate personal sympathy between Agassiz and his students.

For this occasion also were written the well-

known birthday verses by Longfellow, which were read the next day at a dinner given to Agassiz by the "Saturday Club." In speaking of Longfellow's relation to this club, Holmes says: "On one occasion he read a short poem at the table. It was in honor of Agassiz's birthday, and I cannot forget the very modest, delicate musical way in which he read his charming verses." Although included in many collections of Longfellow's Poems, they are reproduced here, because the story seems incomplete without them.

THE FIFTIETH BIRTHDAY OF AGASSIZ.

It was fifty years ago,
In the pleasant month of May,
In the beautiful Pays de Vaud,
A child in its cradle lay.

And Nature, the old nurse, took
The child upon her knee,
Saying: "Here is a story-book
Thy Father has written for thee."

"Come wander with me," she said,
"Into regions yet untrod;
And read what is still unread
In the manuscripts of God."

And he wandered away and away
With Nature, the dear old nurse,

Who sang to him night and day
The rhymes of the universe.

And whenever the way seemed long,
Or his heart began to fail,
She would sing a more wonderful song,
Or tell a more marvelous tale.

So she keeps him still a child,
And will not let him go,
Though at times his heart beats wild
For the beautiful Pays de Vaud;

Though at times he hears in his dreams
The Ranz des Vaches of old,
And the rush of mountain streams
From glaciers clear and cold;

And the mother at home says, "Hark!
For his voice I listen and yearn;
It is growing late and dark,
And my boy does not return!"

May 28, 1857.

Longfellow had an exquisite touch for occasions of this kind, whether serious or mirthful. Once, when some years after this Agassiz was keeping Christmas Eve with his children and grandchildren, there arrived a basket of wine containing six old bottles of rare vintage. They introduced themselves in a charming French "Noel" as pilgrims from beyond

the sea who came to give Christmas greeting to the master of the house. Gay pilgrims were these six "gaillards," and they were accompanied by the following note: —

"A Merry Christmas and Happy New Year to all the house of Agassiz!

"I send also six good wishes in the shape of bottles. Or is it wine?

"It is both; good wine and good wishes, and kind memories of you on this Christmas Eve." H. W. L.

An additional word about the "Saturday Club," the fame of which has spread beyond the city of its origin, may not be amiss here. Notwithstanding his close habits of work Agassiz was eminently social, and to this club he was especially attached. Dr. Holmes says of it in his volume on Emerson, who was one of its most constant members: "At one end of the table sat Longfellow, florid, quiet, benignant, soft-voiced, a most agreeable rather than a brilliant talker, but a man upon whom it was always pleasant to look, — whose silence was better than many another man's conversation. At the other end sat Agassiz, robust, sanguine, animated, full of talk, boy-like in his laughter. The stranger who should have asked who were the men ranged along the sides of the table

would have heard in answer the names of Hawthorne, Motley, Dana, Lowell, Whipple, Peirce, the distinguished mathematician, Judge Hoar, eminent at the bar and in the cabinet, Dwight, the leading musical critic of Boston for a whole generation, Sumner, the academic champion of freedom, Andrew, 'the great War Governor' of Massachusetts, Dr. Howe, the philanthropist, William Hunt, the painter, with others not unworthy of such company." We may complete the list and add the name of Holmes himself, to whose presence the club owed so much of its wit and wisdom. In such company the guests were tempted to linger long, and if Holmes has described the circle around the table, Lowell has celebrated the late walk at night across the bridge as he and Agassiz returned to Cambridge on foot together. To break the verse by quotation would mar the quiet scene and interrupt the rambling pleasant talk it so graphically describes. But we may keep the parting words:

"At last, arrived at where our paths divide,
'Good night!' and, ere the distance grew too wide,
'Good night!' again; and now with cheated ear
I half hear his who mine shall never hear." [1]

[1] See Memorial poem, entitled *Agassiz*, by James Russell Lowell.

Agassiz was now the possessor of a small laboratory by the immediate sea-coast. It was situated on the northeastern shore of Nahant, within a stone's throw of broken and bold rocks, where the deep pools furnished him with ever fresh specimens from natural aquariums which were re-stocked at every rise of the tide. This laboratory, with a small cottage adjoining, which was shared during the summer between his own family and that of Professor Felton, was the gift of his father-in-law, Mr. Cary. So carefully were his wishes considered that the microscope table stood on a flat rock sunk in the earth and detached from the floor, in order that no footstep or accidental jarring of door or window in other parts of the building might disturb him at his work.

There, summer after summer, he pursued his researches on the medusæ; from the smaller and more exquisite kinds, such as the Pleurobrachyias, Idyias, and Bolinas, to the massive Cyaneas, with their large disks and heavy tentacles, many yards in length. Nothing can be prettier than the smaller kinds of jelly-fishes. Their structure is so delicate, yet so clearly defined, their color so soft, yet often so brilliant, their texture so transparent, that

COTTAGE AT NAHANT.

you seek in vain among terrestrial forms for terms of comparison, and are tempted to say that nature has done her finest work in the sea rather than on land. Sometimes hundreds of these smaller medusæ might be seen floating together in the deep glass bowls, or jars, or larger vessels with which Agassiz's laboratory at Nahant was furnished. When the supply was exhausted, new specimens were easily to be obtained by a row in a dory a mile or two from shore, either in the hot, still noon, when the jelly-fish rise toward the surface, or at night, over a brilliantly phosphorescent sea, when they are sure to be abundant, since they themselves furnish much of the phosphorescence. In these little excursions, many new and interesting things came to his nets beside those he was seeking. The fishermen, also, were his friends and coadjutors. They never failed to bring him whatever of rare or curious fell into their hands, sometimes even turning aside from their professional calling to give the laboratory preference over the market.

Neither was his summer work necessarily suspended during winter, his Cambridge and Nahant homes being only about fifteen miles distant from each other. He writes to his

friends, the Holbrooks, at this time, "You can hardly imagine what a delightful place Nahant is for me now. I can trace the growth of my little marine animals all the year round without interruption, by going occasionally over there during the winter. I have at this moment young medusæ budding from their polyp nurses, which I expect to see freeing themselves in a few weeks." In later years, when his investigations on the medusæ were concluded, so far as any teaching from the open book of Nature can be said to be concluded, he pursued here, during a number of years, investigations upon the sharks and skates. For this work, which should have made one of the series of "Contributions," he left much material, unhappily not ready for publication.

In August, 1857, Agassiz received the following letter from M. Rouland, Minister of Public Instruction in France.

TO PROFESSOR AGASSIZ.

PARIS, *August* 19, 1857.

SIR, — By the decease of M. d'Orbigny the chair of paleontology in the Museum of Natural History in Paris becomes vacant. You are French; you have enriched your native country by your eminent works and laborious

researches. You are a corresponding member of the Institute. The emperor would gladly recall to France a savant so distinguished. In his name I offer you the vacant chair, and should congratulate your country on the return of a son who has shown himself capable of such devotion to science.

Accept the assurance of my highest esteem,

ROULAND.

Had it been told to Agassiz when he left Europe that in ten years he should be recalled to fill one of the coveted places at the Jardin des Plantes, the great centre of scientific life and influence in France, he would hardly have believed himself capable of refusing it. Nor does a man reject what would once have seemed to him a great boon without a certain regret. Such momentary regret he felt perhaps, but not an instant of doubt. His answer expressed his gratitude and his pleasure in finding himself so remembered in Europe. He pleaded his work in America as his excuse for declining a position which he nevertheless considered the most brilliant that could be offered to a naturalist. In conclusion he adds: "Permit me to correct an error concerning myself. I am not French, although of French

origin. My family has been Swiss for centuries, and spite of my ten years' exile I am Swiss still."

The correspondence did not end here. A few months later the offer was courteously renewed by M. Rouland, with the express condition that the place should remain open for one or even two years to allow time for the completion of the work Agassiz had now on hand. To this second appeal he could only answer that his work here was the work not of years, but of his life, and once more decline the offer. That his refusal was taken in good part is evident from the fact that the order of the Legion of Honor was sent to him soon after, and that from time to time he received friendly letters from the Minister of Public Instruction, who occasionally consulted him upon general questions of scientific moment.

This invitation excited a good deal of interest among Agassiz's old friends in Europe. Some urged him to accept it, others applauded his resolve to remain out of the great arena of competition and ambition. Among the latter was Humboldt. The following extract is from a letter of his (May 9, 1857) to Mr. George Ticknor, of Boston, who had been one of Agassiz's kindest and best friends in Amer-

ica from the moment of his arrival. "Agassiz's large and beautiful work (the first two volumes) reached me a few days since. It will produce a great effect both by the breadth of its general views and by the extreme sagacity of its special embryological observations. I have never believed that this illustrious man, who is also a man of warm heart, a noble soul, would accept the generous offers made to him from Paris. I knew that gratitude would keep him in the new country, where he finds such an immense territory to explore, and such liberal aid in his work."

In writing of this offer to a friend Agassiz himself says: "On one side, my cottage at Nahant by the sea-shore, the reef of Florida, the vessels of the Coast Survey at my command from Nova Scotia to Mexico, and, if I choose, all along the coast of the Pacific, — and on the other, the Jardin des Plantes, with all its accumulated treasures. Rightly considered, the chance of studying nature must prevail over the attractions of the (Paris) Museum. I hope I shall be wise enough not to be tempted even by the prospect of a new edition of the 'Poissons Fossiles.'"

To his old friend Charles Martins, the naturalist, he writes: "The work I have under-

taken here, and the confidence shown in me by those who have at heart the intellectual development of this country, make my return to Europe impossible for the present; and, as you have well understood, I prefer to build anew here rather than to fight my way in the midst of the coteries of Paris. Were I offered absolute power for the reorganization of the Jardin des Plantes, with a revenue of fifty thousand francs, I should not accept it. I like my independence better."

The fact that Agassiz had received and declined this offer from the French government seemed to arouse anew the public interest in his projects and prospects here. It was felt that a man who was ready to make an alliance so uncompromising with the interests of science in the United States should not be left in a precarious and difficult position. His collections were still heaped together in a slight wooden building. The fact that a great part of them were preserved in alcohol made them especially in danger from fire. A spark, a match carelessly thrown down, might destroy them all in half an hour, for with material so combustible, help would be unavailing. This fear was never out of his mind. It disturbed his peace by day and his

rest by night. That frail structure, crowded from garret to cellar with seeming rubbish, with boxes, cases, barrels, casks still unpacked and piled one above the other, held for him the treasure out of which he would give form and substance to the dream of his boyhood and the maturer purpose of his manhood. The hope of creating a great museum intelligently related in all its parts, reflecting nature, and illustrating the history of the animal kingdom in the past and the present, had always tempted his imagination. Nor was it merely as a comprehensive and orderly collection that he thought of it. From an educational point of view it had an even greater value for him. His love of teaching prompted him no less than his love of science. Indeed, he hoped to make his ideal museum a powerful auxiliary in the interests of the schools and teachers throughout the State, and less directly throughout the country. He hoped it would become one of the centres for the radiation of knowledge, and that the investigations carried on within its walls would find means of publication, and be a fresh, original contribution to the science of the day. This hope was fully realized. The first number of the Museum Bulletin was published in March,

1863, the first number of the Illustrated Catalogue in 1864, and both publications have been continued with regularity ever since.[1]

In laying out the general plan, which was rarely absent from his thought, he distinguished between the demands which the specialist and the general observer might make upon an institution intended to instruct and benefit both. Here the special student should find in the laboratories and work rooms all the needed material for his investigations, stored in large collections, with duplicates enough to allow for that destruction of specimens which is necessarily involved in original research. The casual visitor meanwhile should walk through exhibition rooms, not simply crowded with objects to delight and interest him, but so arranged that the selection of every specimen should have reference to its part and place in nature; while the whole should be so combined as to explain, so far as known, the faunal and systematic relations of animals in the actual world, and in the geological formations; or, in other words, their succession in time, and their distribution in space.

[1] At the time of Agassiz's death nearly three volumes of the Bulletin had been published, and the third volume of the *Memoirs* (Illustrated Catalogue, No. 7) had been begun.

A favorite part of his plan was a room which he liked to call his synoptic room. Here was to be the most compact and yet the fullest statement in material form of the animal kingdom as a whole, an epitome of the creation, as it were. Of course the specimens must be few in so limited a space, but each one was to be characteristic of one or other of the various groups included under every large division. Thus each object would contribute to the explanation of the general plan. On the walls there were to be large, legible inscriptions, serving as a guide to the whole, and making this room a simple but comprehensive lesson in natural history. It was intended to be the entrance room for visitors, and to serve as an introduction to the more detailed presentation of the same vast subject, given by the faunal and systematic collections in the other exhibition rooms.

The standard of work involved in this scheme is shown in many of his letters to his students and assistants, to whom he looked for aid in its execution. To one he writes: "You will get your synoptic series only after you have worked up in detail the systematic collection as a whole, the faunal collections in their totality, the geological sequence of the

entire group under consideration, as well as its embryology and geographical distribution. Then alone will you be able to know the representatives in each series which will best throw light upon it and complete the other series."

He did not live to fill in this comprehensive outline with the completeness which he intended, but all its details were fully explained by him before his death, and since that time have been carried out by his son, Alexander Agassiz. The synoptic room, and in great part the systematic and faunal collections, are now arranged and under exhibition, and the throngs of visitors during all the pleasant months of the year attest the interest they excite.

This conception, of which the present Museum is the expression, was matured in the brain of the founder before a brick of the building was laid, or a dollar provided for the support of such an institution. It existed for him as his picture does for the artist before it lives upon the canvas. One must have been the intimate companion of his thoughts to know how and to what degree it possessed his imagination, to his delight always, yet sometimes to his sorrow also, for he had it and he

had it not. The thought alone was his; the means of execution were far beyond his reach.

His plan was, however, known to many of his friends, and especially he had explained it to Mr. Francis C. Gray, whose intellectual sympathy made him a delightful listener to the presentation of any enlightened purpose. In 1858 Mr. Gray died, leaving in his will the sum of fifty thousand dollars for the establishment of a Museum of Comparative Zoölogy, with the condition that this sum should be used neither for the erection of buildings nor for salaries, but for the purely scientific needs of such an institution. Though this bequest was not connected in set terms with the collections already existing in Cambridge, its purpose was well understood; and Mr. Gray's nephew, Mr. William Gray, acting upon the intention of his uncle as residuary legatee, gave it into the hands of the President and Fellows of Harvard University. In passing over this trust, the following condition, among others, was made, namely: "That neither the collections nor any building which may contain the same shall ever be designated by any other name than the Museum of Comparative Zoölogy at Harvard." This is worth noting, because the title was chosen and in-

sisted upon by Agassiz himself in opposition to many who would have had it called after him. To such honor as might be found in connecting his own name with a public undertaking of any kind he was absolutely indifferent. It was characteristic of him to wish, on the contrary, that the name should be as impersonal and as comprehensive as the uses and aims of the institution itself. Yet he could not wholly escape the distinction he deprecated. The popular imagination, identifying him with his work, has re-christened the institution; and, spite of its legal title, its familiar designation is almost invariably the "Agassiz Museum."

Mr. Gray's legacy started a movement which became every day more active and successful. The university followed up his bequest by a grant of land suitable for the site of the building, and since the Gray fund provided for no edifice, an appeal was made to the Legislature of Massachusetts to make good that deficiency. The Legislature granted lands to the amount of one hundred thousand dollars, on condition that a certain additional contribution should be made by private subscription. The sum of seventy-one thousand one hundred and twenty-five dollars, somewhat exceed-

MUSEUM OF COMPARATIVE ZOÖLOGY.

ing that stipulated, was promptly subscribed, chiefly by citizens of Boston and Cambridge, and Agassiz himself gave all the collections he had brought together during the last four or five years, estimated, merely by the outlay made upon them, at ten thousand dollars. The architects, Mr. Henry Greenough and Mr. George Snell, offered the plan as their contribution. The former had long been familiar with Agassiz's views respecting the internal arrangements of the building. The main features had been discussed between them, and now, that the opportunity offered, the plan was practically ready for execution. These events followed each other so rapidly that although Mr. Gray's bequest was announced only in December, 1858, the first sod was turned and the corner-stone of the future Museum was laid on a sunny afternoon in the following June, 1859.[1]

[1] The plan, made with reference to the future increase as well as the present needs of the Museum, included a main building 364 feet in length by 64 in width, with wings 205 feet in length by 64 in width, the whole enclosing a hollow square. The structure erected 1859–60 was but a section of the north wing, being two fifths of its whole length. This gave ample space at the time for the immediate requirements of the Museum. Additions have since been made, and the north wing is completed, while the Peabody Museum occupies a portion of the ground allotted to the south wing.

This event, so full of significance for Agassiz, took place a few days before he sailed for Europe, having determined to devote the few weeks of the college and school vacation to a flying visit in Switzerland. The incidents of this visit were of a wholly domestic nature and hardly belong here. He paused a few days in Ireland and England to see his old friends, the Earl of Enniskillen and Sir Philip Egerton, and review their collections. A day or two in London gave him, in like manner, a few hours at the British Museum, a day with Owen at Richmond, and an opportunity to greet old friends and colleagues called together to meet him at Sir Roderick Murchison's. He allowed himself also a week in Paris, made delightful by the cordiality and hospitality of the professors of the Jardin des Plantes, and by the welcome he received at the Academy, when he made his appearance there. The happiest hours of this brief sojourn in Paris were perhaps spent with his old and dear friend Valenciennes, the associate of earlier days in Paris, when the presence of Cuvier and Humboldt gave a crowning interest to scientific work there.

From Paris he hastened on to his mother in Switzerland, devoting to her and to his imme-

diate family all the time which remained to him before returning to his duties in Cambridge. They were very happy weeks, passed, for the most part, in absolute retirement, at Montagny, near the foot of the Jura, where Madame Agassiz was then residing with her daughter. The days were chiefly spent in an old-fashioned garden, where a corner shut in by ivy and shaded by trees made a pleasant out-of-door sitting-room. There he told his mother, as he had never been able to tell her in letters, of his life and home in the United States, and of the Museum to which he was returning, and which was to give him the means of doing for the study of nature all he had ever hoped to accomplish. His quiet stay here was interrupted only by a visit of a few days to his sister at Lausanne, and a trip to the Diablerets, where his brother, then a great invalid, was staying. He also passed a day or two at Geneva, where he was called to a meeting of the Helvetic Society, which gave him an opportunity of renewing old ties of friendship, as well as scientific relations, with the naturalists of his own country, with Pictet de la Rive, de Candolle, Favre, and others.

CHAPTER XIX.

1860–1863: ÆT. 53–56.

Return to Cambridge. — Removal of Collection to New Museum Building. — Distribution of Work. — Relations with his Students. — Breaking out of the War between North and South. — Interest of Agassiz in the Preservation of the Union. — Commencement of Museum Publications. — Reception of Third and Fourth Volumes of "Contributions." — Copley Medal. — General Correspondence. — Lecturing Tour in the West. — Circular Letter concerning Anthropological Collections. — Letter to Mr. Ticknor concerning Geographical Distribution of Fishes in Spain.

On his return to Cambridge at the end of September, Agassiz found the Museum building well advanced. It was completed in the course of the next year, and the dedication took place on the 13th November, 1860. The transfer of the collections to their new and safe abode was made as rapidly as possible, and the work of developing the institution under these more favorable conditions moved steadily on. The lecture rooms were at once opened, not only to students but to other persons not connected with the university. Especially welcome were teachers of schools

for whom admittance was free. It was a great pleasure to Agassiz thus to renew and strengthen his connection with the teachers of the State, with whom, from the time of his arrival in this country, he had held most cordial relations, attending the Teachers' Institutes, visiting the normal schools, and associating himself actively, as far as he could, with the interests of public education in Massachusetts. From this time forward his college lectures were open to women as well as to men. He had great sympathy with the desire of women for larger and more various fields of study and work, and a certain number of women have always been employed as assistants at the Museum.

The story of the next three years was one of unceasing but seemingly uneventful work. The daylight hours from nine or ten o'clock in the morning were spent, with the exception of the hour devoted to the school, at the Museum, not only in personal researches and in lecturing, but in organizing, distributing, and superintending the work of the laboratories, all of which was directed by him. Passing from bench to bench, from table to table, with a suggestion here, a kindly but scrutinizing glance there, he made his sympathetic pres-

ence felt by the whole establishment. No man ever exercised a more genial personal influence over his students and assistants. His initiatory steps in teaching special students of natural history were not a little discouraging. Observation and comparison being in his opinion the intellectual tools most indispensable to the naturalist, his first lesson was one in *looking*. He gave no assistance ; he simply left his student with the specimen, telling him to use his eyes diligently, and report upon what he saw. He returned from time to time to inquire after the beginner's progress, but he never asked him a leading question, never pointed out a single feature of the structure, never prompted an inference or a conclusion. This process lasted sometimes for days, the professor requiring the pupil not only to distinguish the various parts of the animal, but to detect also the relation of these details to more general typical features. His students still retain amusing reminiscences of their despair when thus confronted with their single specimen ; no aid to be had from outside until they had wrung from it the secret of its structure. But all of them have recognized the fact that this one lesson in looking, which forced them to such careful scrutiny of the

object before them, influenced all their subsequent habits of observation, whatever field they might choose for their special subject of study. One of them who was intending to be an entomologist concludes a very clever and entertaining account of such a first lesson, entirely devoted to a single fish, with these words: "This was the best entomological lesson I ever had, — a lesson whose influence has extended to the details of every subsequent study; a legacy the professor has left to me, as he left it to many others, of inestimable value, which we could not buy, with which we could not part." [1]

But if Agassiz, in order to develop independence and accuracy of observation, threw his students on their own resources at first, there was never a more generous teacher in the end than he. All his intellectual capital was thrown open to his pupils. His original material, his unpublished investigations, his most precious specimens, his drawings and illustrations were at their command. This liberality led in itself to a serviceable training, for he taught them to use with respect the valuable, often unique, objects intrusted to their care. Out of the intellectual good-fel-

[1] *In the Laboratory with Agassiz*, by S. H. Scudder.

lowship which he established and encouraged in the laboratory grew the warmest relations between his students and himself. Many of them were deeply attached to him, and he was extremely dependent upon their sympathy and affection. By some among them he will never be forgotten. He is still their teacher and their friend, scarcely more absent from their work now than when the glow of his enthusiasm made itself felt in his personal presence.

But to return to the distribution of his time in these busy days. Having passed, as we have seen, the greater part of the day in the Museum and the school, he had the hours of the night for writing, and rarely left his desk before one or two o'clock in the morning, or even later. His last two volumes of the "Contributions," upon the Acalephs, were completed during these years. In the mean time, the war between North and South had broken out, and no American cared more than he for the preservation of the Union and the institutions it represented. He felt that the task of those who served letters and science was to hold together the intellectual aims and resources of the country during this struggle for national existence, to fortify the strong-

holds of learning, abating nothing of their efficiency, but keeping their armories bright against the return of peace, when the better weapons of civilization should again be in force. Toward this end he worked with renewed ardor, and while his friends urged him to suspend operations at the Museum and husband his resources until the storm should have passed over, he, on the contrary, stimulated its progress by every means in his power. Occasionally he was assisted by the Legislature, and early in this period an additional grant of ten thousand dollars was made to the Museum. With this grant was begun the series of illustrated publications already mentioned, known as the "Bulletin of the Museum of Comparative Zoölogy in Cambridge."

During this period he urged also the foundation of a National Academy of Sciences, and was active in furthering its organization and incorporation (1863) by Congress. With respect to this effort, and to those he was at the same time making for the Museum, he was wont to recall the history of the University of Berlin. In an appeal to the people in behalf of the intellectual institutions of the United States during the early years of the war he says: "A well known fact in the his-

tory of Germany has shown that the moment of political danger may be that in which the firmest foundations for the intellectual strength of a country may be laid. When in 1806, after the battle of Jena, the Prussian monarchy had been crushed and the king was despairing even of the existence of his realm, he planned the foundation of the University of Berlin, by the advice of Fichte, the philosopher. It was inaugurated the very year that the despondent monarch returned to his capital. Since that time it has been the greatest glory of the Prussian crown, and has made Berlin the intellectual centre of Germany."

It may be added here as an evidence of Agassiz's faith in the institutions of the United States and in her intellectual progress that he was himself naturalized in the darkest hour of the war, when the final disruption of the country was confidently prophesied by her enemies. By formally becoming a citizen of the United States he desired to attest his personal confidence in the stability of her Constitution and the justice of her cause.

Some light is thrown upon the work and incidents of these years by the following letters: —

FROM SIR PHILIP DE GREY EGERTON.

LONDON, ALBEMARLE ST., *April* 16, 1861.

MON CHER AGASS.,[1] — I have this morning received your handsome and welcome present of the third volume of your great undertaking, and this reminds me how remiss I have been in not writing to you sooner. In fact, I have had nothing worth writing about, and I know your time is too valuable to be intrenched upon by letters of mere gossip. I have not of course had time to peruse any portion of the monograph, but I have turned over the pages and seen quite enough to sharpen my appetite for the glorious scientific feast you have so liberally provided. And now that the weight is off your mind, I hope shortly to hear that you are about to fulfill this year the promise you made of returning to England for a good long visit, only postponed by circumstances you could not have foreseen. Now that you have your son as the sharer of your labors, you will be able to leave him in charge during your absence, and so divest your mind of all care and anxiety with reference to matters over the water. Here we are all fighting most furiously about Celts and flint imple-

[1] An affectionate abbreviation which Sir Philip often used for him.

ments, struggle for life, natural selection, the age of the world, races of men, biblical dates, apes, and gorillas, etc., and the last duel has been between Owen and Huxley on the anatomical distinction of the pithecoid brain compared with that of man. Theological controversy has also been rife, stirred up by the "Essays and Reviews," of which you have no doubt heard much. For myself, I have been busy preparing, in conjunction with Huxley, another decade of fossil fishes, all from the old red of Scotland. . . . Enniskillen is quite well. He is now at Lyme Regis. . . .

At about this time the Copley Medal was awarded to Agassiz, a distinction which was the subject of cordial congratulation from his English friends.

FROM SIR RODERICK MURCHISON.

BELGRAVE SQUARE, *March*, 1862.

MY DEAR AGASSIZ, — Your letter of the 14th February was a great surprise to me. I blamed myself for not writing you sooner than I did on the event which I had long been anxious to see realized; but I took it for granted that you had long before received the official announcement from the foreign secre-

tary that you were, at the last anniversary of the Royal Society, the recipient of the highest honor which our body can bestow, whether on a foreigner or a native. . . . On going to the Royal Society to-day I found that the President and Secretaries were much surprised that you had never answered the official letter sent to you on the 1st or 2d December by the Foreign Secretary, Professor Müller, of Cambridge. He wrote to announce the award, and told you the Copley Medal was in his safe keeping till you wrote to say what you wished to have done with it. I have now recommended him to transmit it officially to you through the United States Minister, Mr. Adams. In these times of irritation, everything which soothes and calms down angry feelings ought to be resorted to; and I hope it may be publicly known that when our newspapers were reciprocating all sorts of rudenesses, the men of science of England thought of nothing but honoring a beloved and eminent savant of America.

I thank you for your clear and manly view of the North and South, which I shall show to all our mutual friends. Egerton, who is now here, was delighted to hear of you, as well as Huxley, Lyell, and many others. . . .

In a paper just read to the Geological Society Professor Ramsay has made a stronger demand on the powers of ice than you ever did. He imagines that every Swiss lake north and south (Geneva, Neuchâtel, Como, etc.) has been scooped out, and the depressions excavated by the abrading action of the glaciers. . . .

FROM SIR PHILIP DE GREY EGERTON.

ALBEMARLE ST., LONDON, *March* 11, 1862.

MON CHER AGASS., — As I am now settled in London for some months, I take the first opportunity of writing to congratulate you on the distinction which has been conferred upon you by the Royal Society, and I will say that you have most fully earned it. I rejoice exceedingly in the decision the Council have arrived at. I only regret I was not on the Council myself to have advocated your high claims and taken a share in promoting your success. It is now long since I have heard from you, but this terrible disruption between the North and South has, I suppose, rendered the pursuit of science rather difficult, and the necessary funds also difficult of attainment. I should like very much to hear how you are getting on, and whether there is any like-

lihood of your being able to come over in the course of the summer or autumn. I fully expected you last year, and was very much disappointed that you could not realize your intention. I have this day sent to you through Baillière, the last decade of the Jermyn St. publications.[1] You will see that Huxley has taken up the subject of the Devonian fishes in a truly scientific spirit. . . .

FROM OWEN TO AGASSIZ.

BRITISH MUSEUM, 1862.

MY DEAR AGASSIZ, — I have received, and since its reception have devoted most of my spare moments to the study of, your fourth volume of the "Natural History of the United States," — a noble contribution to our science, and worthy of your great name.

The demonstration of the unity of plan pervading the diversities of the Polyps, Hydroids, Acalephal and Echinodermal modifications of your truly natural group of Radiates, is to my mind perfect, and I trust that the harsh and ugly and essentially error-breeding name of Coelenterata may have received its final sentence of exile from lasting and rational zoölogical terminology.

[1] Publications of the Geological Survey of England.

I shall avail myself of opportunities for bringing myself to your recollection by such brochures as I have time for. One of them will open to your view something of the nature of the contest here waging to obtain for England a suitable Museum of Natural History, equivalent to her wealth and colonies and maritime business. In this I find you a valuable ally, and have cited from the Reports of your Museum of Comparative Zoölogy in support of my own claims for space.

I was glad to hear from Mr. Bates that the Megatherium had not gone to the bottom, but had been rescued, and that it was probably ere this in your Museum at Cambridge. I trust it may be so.

A line from you or the sight of any friend of yours is always cheering to me. Our friends Enniskillen and Egerton are both well. . . .

I remain ever truly yours,

RICHARD OWEN.

As has been seen by a previous letter from Sir Roderick Murchison, Agassiz tried from time to time to give his English friends more just views of our national struggle. The letter to which the following is an answer is

missing, but one may easily infer its tenor, and the pleasure it had given him.

TO SIR PHILIP DE GREY EGERTON.

NAHANT, MASS., *August* 15, 1862.

. . . I feel so thankful for your words of sympathy, that I lose not an hour in expressing my feeling. It has been agonizing week after week to receive the English papers, and to see there the noble devotion of the men of the North to their country and its government, branded as the service of mercenaries. You know I am not much inclined to meddle with politics; but I can tell you that I have never seen a more generous and prompt response to the call of country than was exhibited last year, and is exhibiting now, in the loyal United States. In the last six weeks nearly 300,000 men have volunteered, and I am satisfied that the additional 300,000 will be forthcoming without a draft in the course of the next month. And believe me, it is not for the sake of the bounty they come forward, for our best young men are the first to enlist; if anything can be objected to these large numbers of soldiers, it is that it takes away the best material that the land possesses. I thank you once more for your warm sympathy.

I needed it the more, as it is almost the first friendly word of that kind I have received from England, and I began to question the humanity of your civilization. . . . Under present circumstances, you can well imagine that I cannot think of leaving Cambridge, even for a few weeks, much as I wish to take some rest, and especially to meet your kind invitation. But I feel that I have a debt to pay to my adopted country, and all I can now do is to contribute my share toward maintaining the scientific activity which has been awakened during the last few years, and which even at this moment is on the increase.

I am now at Nahant, on the sea-shore, studying embryology chiefly with reference to paleontology, and the results are most satisfactory. I have had an opportunity already of tracing the development of the representatives of three different families, upon the embryology of which we had not a single observation thus far, and of making myself familiar with the growth of many others. With these accessions I propose next winter seriously to return to my first scientific love. . . .

I have taken with me to the sea-shore your and Huxley's "Contributions to the Devonian

Fishes," and also your notice of Carboniferous fish-fauna; but I have not yet had a chance to study them critically, from want of time, having been too successful with the living specimens to have a moment for the fossils. The season for sea-shore studies is, however, drawing rapidly to an end, and then I shall have more leisure for my old favorites.

I am very sorry to hear such accounts of the sufferings of the manufacturing districts in England. I wish I could foretell the end of our conflict; but I do not believe it can now be ended before slavery is abolished, though I thought differently six months ago. The most conservative men at the North have gradually come to this conviction, and nobody would listen for a moment to a compromise with the southern slave power. Whether we shall get rid of it by war measures or by an emancipation proclamation, I suppose the President himself does not yet know. I do not think that we shall want more money than the people are willing to give. Private contributions for the comfort of the army are really unbounded. I know a gentleman, not among the richest in Boston, who has already contributed over $30,000; and I heard yesterday of a shop-boy who tendered all his earnings of

many years to the relief committee, — $2,000, retaining *nothing* for himself, — and so it goes all round. Of course we have croakers and despondent people, but they no longer dare to raise their voices; from which I infer that there is no stopping the storm until by the natural course of events the atmosphere is clear and pure again.

Ever truly your friend,

LOUIS AGASSIZ.

Agassiz had now his time more at his own disposal since he had given up his school and had completed also the fourth volume of his "Contributions." Leisure time he could never be said to have, but he was free to give all his spare time and strength to the Museum, and to this undivided aim, directly or indirectly, the remainder of his life was devoted. Although at intervals he received generous aid from the Legislature or from private individuals for the further development of the Museum, its growth outran such provision, and especially during the years of the war the problem of meeting expenses was often difficult of solution. To provide for such a contingency Agassiz made in the winter of 1863 the most extensive lecturing tour he

had ever undertaken, even in his busiest lecturing days. He visited all the large cities and some of the smaller towns from Buffalo to St. Louis. While very remunerative, and in many respects delightful, since he was received with the greatest cordiality, and lectured everywhere to enthusiastic crowds, this enterprise was, nevertheless, of doubtful economy even for his scientific aims. Agassiz was but fifty-six, yet his fine constitution began to show a fatigue hardly justified by his years, and the state of his health was already a source of serious anxiety to his friends. He returned much exhausted, and passed the summer at Nahant, where the climate always benefited him, while his laboratory afforded the best conditions for work. If this summer home had a fault, it was its want of remoteness. He was almost as much beset there, by the interruptions to which a man in his position is liable, as in Cambridge.

His letters show how constantly during this nominal vacation his Museum and its interests occupied his thoughts. One is to his brother-in-law, Thomas G. Cary, whose residence was in San Francisco, and who had been for years his most efficient aid in obtaining collections from the Pacific Coast.

TO MR. THOMAS G. CARY.

CAMBRIDGE, *March* 23, 1863.

DEAR TOM, — For many years past your aid in fostering the plans of the Museum in Cambridge has greatly facilitated the progress of that establishment in everything relating to the Natural History of California, and now that it has become desirable to extend our scheme to objects which have thus far been neglected I make another appeal to you.

Every day the history of mankind is brought into more and more intimate connection with the natural history of the animal creation, and it is now indispensable that we should organize an extensive collection to illustrate the natural history of the uncivilized races. Your personal acquaintance with business friends in almost every part of the globe has suggested to me the propriety of addressing to you a circular letter, setting forth the objects wanted, and requesting of you the favor to communicate it as widely as possible among your friends.

To make the most instructive collections relative to the natural history of mankind, two classes of specimens should be brought together, one concerning the habits and pursuits

of the races, the other concerning the physical constitution of the races themselves.

With reference to the first it would be desirable to collect articles of clothing and ornaments of all the races of men, their implements, tools, weapons, and such models or drawings of their dwellings as may give an idea of their construction; small canoes and oars as models of their vessels, or indications of their progress in navigation; in one word, everything that relates to their avocations, their pursuits, their habits, their mode of worship, and whatever may indicate the dawn or progress of the arts among them. As to articles of clothing, it would be preferable to select such specimens as have actually been worn or even cast off, rather than new things which may be more or less fanciful and not indicate the real natural condition and habits of a race.

With regard to the collections intended to illustrate the physical constitution of the races it is more difficult to obtain instructive specimens, as the savage races are generally inclined to hold sacred all that relates to their dead; yet whenever an opportunity is afforded to obtain skulls of the natives of different parts of the world, it should be industriously improved, and good care taken to mark the

skulls in such a way that their origin cannot be mistaken. Beside this, every possible effort should be made to obtain perfect heads, preserved in alcohol, so that all their features may be studied minutely and compared. Where this cannot be done portraits or photographs may be substituted.

Trusting that you may help me in this way to bring together in Cambridge a more complete collection, illustrative of the natural history of mankind than exists thus far anywhere,[1]

I remain, ever truly your friend and brother,

LOUIS AGASSIZ.

The following letter to Mr. Ticknor is in the same spirit as previous ones to Mr. Haldeman and others, concerning the distribution of fishes in America. It is given at the risk of some repetition, because it illustrates Agassiz's favorite idea that a key to the original combination of faunæ in any given system of fresh waters, might be reached through a closer study than has yet been possible of the geographical or local circumscription of their inhabitants.

[1] All the ethnographical collections of the Museum of Comparative Zoölogy have now been transferred to the Peabody Museum, where they more properly belong.

TO MR. GEORGE TICKNOR.

NAHANT, *October* 24, 1863.

MY DEAR SIR, — Among the schemes which I have devised for the improvement of the Museum, there is one for the realization of which I appeal to your aid and sympathy. Thus far the natural productions of the rivers and lakes of the world have not been compared with one another, except what I have done in comparing the fishes of the Danube with those of the Rhine and of the Rhone, and those of the great Canadian lakes with those of the Swiss lakes.

I now propose to resume this subject on the most extensive scale, since I see that it has the most direct bearing upon the transmutation theory. . . . First let me submit to you my plan.

Rivers and lakes are isolated by the land and sea from one another. The question is, then, how they came to be peopled with inhabitants differing both from those on land and those in the sea, and how does it come that every hydrographic basin has its own inhabitants more or less different from those of any other basin? Take the Ganges, the Nile, and the Amazons. There is not a living being

in the one alike to any one in the others, etc. Now to advance the investigation to the point where it may tell with reference to the scientific doctrines at present under discussion, it is essential to know the facts in detail, with reference to every fresh-water basin on earth. I have already taken means to obtain the tenants of all the rivers of Brazil, and partly of Russia, and I hope you may be able to put me in the way of getting those of Spain, if not of some other country beside. The plan I propose for that country would be worthy of the Doctors of Salamanca in her brightest days. If this alone were carried out, it would be, I believe, sufficient to settle the whole question.

My idea is to obtain separate collections from all the principal rivers of Spain and Portugal, and even to have several separate collections from the larger rivers, one from their lower course, one from their middle course, and another from their head-waters. Take, for instance, the Douro. One collection ought to be made at Oporto, and several higher up, among its various tributaries and in its upper course; say, one at Zamora and Valladolid, one at Salamanca from the Tormes River, one at Leon from the Esla River, one

at Burgos and Palencia from the northern tributaries, one at Soria and Segovia from the southern tributaries. If this could be done on such a scale as I propose, it would in itself be a work worthy of the Spanish government, and most creditable to any man who should undertake it. The fact is that nothing of the kind has ever been done yet anywhere. A single collection from the Minho would be sufficient, say from Orense or Melgaço. From the northern rivers along the gulf of Biscay all that would be necessary would be one thoroughly complete collection from one of the little rivers that come down from the mountains of Asturias, say from Oviedo.

The Ebro would require a more elaborate survey. From its upper course, one collection would be needed from Haro or Frias or Miranda; another from Saragossa, and one from its mouth, including the minnows common among the brackish waters near the mouth of large rivers. In addition to this, one or two of the tributaries of the Ebro, coming down from the Pyrenees, should be explored in the same manner; say one collection from Pampeluna, and one from Urgel, or any other place on the southern slope of the Pyrenees. A collection made at Barcelona from the river

and the brackish marshes would be equally desirable; another from the river at Valencia, and, if possible, also from its head-waters at Ternel; another from the river Segura at Murcia, and somewhere in the mountains from its head-waters. Granada would afford particular interest as showing what its mountain streams feed. A collection from the Almeria River at Almeria, or from any of the small rivers of the southern coast of Spain, would do; and it would be the more interesting if another from the river Xenil could be obtained at or near Granada, to compare with the inhabitants of the waters upon the southern slope of the Sierra Nevada.

Next would come the Guadalquivir, from which a collection should be made at San Lucar, with the brackish water species; another at Seville or Cordova, one among the head-waters from the Sierra Nevada, and another from the mountains of the Mancha. From the Guadiana a collection from Villa Real, with the brackish species; one from Badajoz, and one from the easternmost head-waters, and about where the river is lost under ground.

The Tagus would again require an extensive exploration. In the first place a thorough

collection of all the species found in the great estuary ought to be made with the view of ascertaining how far marine Atlantic species penetrate into the river basin; then one from Santarem, and another either from Talavera or Toledo or Aranjuez, and one from the head-waters in Guadalaxara, and another in Molina.

The collections made at different stations ought carefully to be kept in distinct jars or kegs, with labels so secure that no confusion or mistake can arise. But the specimens collected at the same station may be put together in the same jar. These collections require, in fact, very little care. (Here some details about mode of putting up specimens, transportation, etc.) If the same person should collect upon different stations, either in the same or in different hydrographic basins, the similarity of the specimens should not be a reason for neglecting to preserve them. What is aimed at is not to secure a variety of species, but to learn in what localities the same species may occur again and again, and what are the localities which nourish different species, no matter whether these species are in themselves interesting or not, new to science or known for ages, whether valuable for the

table or unfit to eat. The mere fact of their distribution is the point to be ascertained, and this, as you see, requires the most extensive collections, affording in themselves comparatively little interest, but likely to lead, by a proper discussion of the facts, to the most unexpected philosophical results. . . . Do, please, what you can in this matter. Spain alone might give us the materials to solve the question of transmutation *versus* creation. I am going to make a similar appeal to my friends in Russia for materials from that country, including Siberia and Kamschatka. Our own rivers are not easily accessible now.

Ever truly your friend,

L. AGASSIZ.

CHAPTER XX.

1863–1864 : ÆT. 56–57.

Correspondence with Dr. S. G. Howe. — Bearing of the War on the Position of the Negro Race. — Affection for Harvard College. — Interest in her General Progress. — Correspondence with Emerson concerning Harvard. — Glacial Phenomena in Maine.

Agassiz's letters give little idea of the deep interest he felt in the war between North and South, and its probable issue with reference to the general policy of the nation, and especially to the relation between the black and white races. Although any judgment upon the accuracy of its conclusions would now be premature, the following correspondence between Agassiz and Dr. S. G. Howe is nevertheless worth considering, as showing how the problem presented itself to the philanthropist and the naturalist from their different stand-points.

FROM DR. S. G. HOWE.

PORTSMOUTH, *August* 3, 1863.

My dear Agassiz, — You will learn by a glance at the inclosed circular the object of the commission of which I am a member.

The more I consider the subject to be examined and reported upon, the more I am impressed by its vastness; the more I see that its proper treatment requires a consideration of political, physiological, and ethnological principles. Before deciding upon any political policy, it is necessary to decide several important questions, which require more knowledge for their solution than I possess.

Among these questions, this one occupies me most now. Is it probable that the African race, represented by less than two million blacks and a little more than two million mulattoes, unrecruited by immigration, will be a persistent race in this country? or will it be absorbed, diluted, and finally effaced by the white race, numbering twenty-four millions, and continually increased by immigration, beside natural causes.

Will not the general practical amalgamation fostered by slavery become more general after its abolition? If so, will not the proportion of mulattoes become greater and that of the pure blacks less? With an increase and final numerical prevalence of mulattoes the question of the fertility of the latter becomes a very important element in the calculation. Can it be a persistent race here where

pure blacks are represented by 2, and the whites by 20–24?

Is it not true that in the Northern States at least the mulatto is unfertile, leaving but few children, and those mainly lymphatic and scrofulous?

In those sections where the blacks and mulattoes together make from seventy to eighty and even ninety per cent. of the whole population will there be, after the abolition of slavery, a sufficiently large influx of whites to counteract the present numerical preponderance of blacks?

It looks now as if the whites would *exploiter* the labors of the blacks, and that social servitude will continue long in spite of political equality.

You will see the importance of considering carefully the natural laws of increase and their modification by existing causes before deciding upon any line of policy.

If there be irresistible natural tendencies to the growth of a persistent black race in the Gulf and river States, we must not make bad worse by futile attempts to resist it. If, on the other hand, the natural tendencies are to the diffusion and final disappearance of the black (and colored) race, then our policy should be modified accordingly.

I should be very glad, my dear sir, if you could give me your views upon this and cognate matters. If, however, your occupations will not permit you to give time to this matter, perhaps you will assist me by pointing to works calculated to throw light upon the subject of my inquiry, or by putting me in correspondence with persons who have the ability and the leisure to write about it.

I remain, dear sir, faithfully,

SAMUEL G. HOWE.

TO DR. S. G. HOWE.

NAHANT, *August* 9, 1863.

MY DEAR DOCTOR, — When I acknowledged a few days ago the receipt of your invitation to put in writing my views upon the management of the negro race as part of the free population of the United States, I stated to you that there was a preliminary question of the utmost importance to be examined first, since whatever convictions may be formed upon that point must necessarily influence everything else relating to the subject. The question is simply this: Is there to be a permanent black population upon the continent after slavery is everywhere abolished and no inducement remains to foster its increase?

Should this question be answered in the negative, it is evident that a wise policy would look to the best mode of removing that race from these States, by the encouragement and acceleration of emigration. Should the question be answered, on the contrary, in the affirmative, then it is plain that we have before us one of the most difficult problems, upon the solution of which the welfare of our own race may in a measure depend, namely, the combination in one social organization of two races more widely different from one another than all the other races. In effecting this combination it becomes our duty to avoid the recurrence of great evils, one of which is already foreshadowed in the advantage which unscrupulous managers are taking of the freedmen, whenever the latter are brought into contact with new social relations.

I will, for the present, consider only the case of the unmixed negroes of the Southern States, the number of which I suppose to be about two millions. It is certainly not less, — it may be a little more. From whatever point of view you look upon these people you must come to the conclusion that, left to themselves, they will perpetuate their race *ad infinitum* where they are. According to the prevalent

theory of the unity of mankind it is assumed that the different races have become what they are in consequence of their settlement in different parts of the world, and that the whole globe is everywhere a fit abode for human beings who adapt themselves to the conditions under which they live. According to the theory of a multiple origin of mankind the different races have first appeared in various parts of the globe, each with the peculiarities best suited to their primitive home. Aside from these theoretical views the fact is, that some races inhabit very extensive tracts of the earth's surface, and are now found upon separate continents, while others are very limited in their range. This distribution is such that there is no reason for supposing that the negro is less fitted permanently to occupy at least the warmer parts of North and South America, than is the white race to retain possession of their more temperate portions. Assuming our pure black race to be only two millions, it is yet larger than the whole number of several races that have held uninterrupted possession of different parts of the globe ever since they have been known to the white race. Thus the Hottentots and the Abyssinians have maintained themselves in

their respective homes without change ever since their existence has been known to us, even though their number is less than that of our pure black population. The same, also, is the case with the population of Australia and of the Pacific islands. The Papuan race, the Negrillo race, the Australian race proper, distinct from one another, as well as from all other inhabitants of the earth, number each fewer inhabitants than already exist of the negro race in the United States alone, not to speak of Central and South America.

This being the case there is, it seems to me, no more reason to expect a disappearance of the negro race from the continent of America without violent interference, than to expect a disappearance of the races inhabiting respectively the South Sea Islands, Australia, the Cape of Good Hope, or any other part of the globe tenanted by the less populous races. The case of the American Indians, who gradually disappear before the white race, should not mislead us, as it is readily accounted for by the peculiar character of that race. The negro exhibits by nature a pliability, a readiness to accommodate himself to circumstances, a proneness to imitate those among whom he lives, — characteristics which are entirely for-

eign to the Indian, while they facilitate in every way the increase of the negro. I infer, therefore, from all these circumstances that the negro race must be considered as permanently settled upon this continent, no less firmly than the white race, and that it is our duty to look upon them as co-tenants in the possession of this part of the world.

Remember that I have thus far presented the case only with reference to the Southern States, where the climate is particularly favorable to the maintenance and multiplication of the negro race. Before drawing any inference, however, from my first assertion that the negro will easily and without foreign assistance maintain himself and multiply in the warmer parts of this continent, let us consider a few other features of this momentous question of race. Whites and blacks may multiply together, but their offspring is never either white or black; it is always mulatto. It is a half-breed, and shares all the peculiarities of half-breeds, among whose most important characteristics is their sterility, or at least their reduced fecundity. This shows the connection to be contrary to the normal state of the races, as it is contrary to the preservation of species in the animal kingdom. . . . Far

from presenting to me a natural solution of our difficulties, the idea of amalgamation is most repugnant to my feelings. It is now the foundation of some of the most ill-advised schemes. But wherever it is practiced, amalgamation among different races produces shades of population, the social position of which can never be regular and settled. From a physiological point of view, it is sound policy to put every possible obstacle to the crossing of the races, and the increase of half-breeds. It is unnatural, as shown by their very constitution, their sickly physique, and their impaired fecundity. It is immoral and destructive of social equality as it creates unnatural relations and multiplies the differences among members of the same community in a wrong direction.

From all this it is plain that the policy to be adopted toward the miscellaneous colored population with reference to a more or less distant future should be totally different from that which applies to the pure black; for while I believe that a wise social economy will foster the progress of every pure race, according to its natural dispositions and abilities, and aim at securing for it a proper field for the fullest development of all its capabili-

ties, I am convinced also that no efforts should be spared to check that which is inconsistent with the progress of a higher civilization and a purer morality. I hope and trust that as soon as the condition of the negro in the warmer parts of our States has been regulated according to the laws of freedom, the colored population in the more northern parts of the country will diminish. By a natural consequence of unconquerable affinities, the colored people in whom the negro nature prevails will tend toward the South, while the weaker and lighter ones will remain and die out among us.

Entertaining these views upon the fundamental questions concerning the races, the next point for consideration is the policy to be adopted under present circumstances, in order to increase the amount of good which is within our grasp and lessen the evil which we may avert. This will be for another letter.

Very truly yours,

LOUIS AGASSIZ.

FROM THE SAME TO THE SAME.

August 10, 1863.

MY DEAR DOCTOR, — I am so deeply impressed with the dangers awaiting the prog-

ress of civilization, should the ideas now generally prevalent about amalgamation gain sufficient ascendency to exert a practical influence upon the management of the affairs of the nation, that I beg leave to urge a few more considerations upon that point.

In the first place let me insist upon the fact that the population arising from the amalgamation of two races is always degenerate, that it loses the excellences of both primitive stocks to retain the vices or defects of both, and never to enjoy the physical vigor of either. In order clearly to appreciate the tendencies of amalgamation, it is indispensable to discriminate correctly between the differences distinguishing one race from another and those existing between different nationalities of the same race. For while the mixture of nationalities of the same race has always proved beneficial as far as we are taught by history, the mixture of races has produced a very different result. We need only look at the inhabitants of Central America, where the white, the negro, and the Indian races are more or less blended, to see the baneful effects of such an amalgamation. The condition of the Indians on the borders of civilization in the United States and in Can-

ada, in their contact with the Anglo-Saxons as well as with the French, testifies equally to the pernicious influence of amalgamation of races. The experience of the Old World points in the same direction at the Cape of Good Hope, in Australia; everywhere, in fact, history speaks as loudly in favor of the mixture of clearly related nations as she does in condemnation of the amalgamation of remote races. We need only think of the origin of the English nation, of that of the United States, etc. The question of breeding in-and-in, that of marriage among close relations, is again quite distinct. In fact, there is hardly a more complicated subject in physiology, or one requiring nicer discriminations, than that of the multiplication of man, and yet it is constantly acted upon as if it needed no special knowledge. I beseech you, therefore, while you are in a position to exert a leading influence in the councils of the nation upon this most important subject to allow no preconceived view, no favorite schemes, no immediate object, to bias your judgment and mislead you. I do not pretend to be in possession of absolute truth. I only urge upon you the consideration of unquestionable facts before you form a final opinion and decide

upon a fixed policy. Conceive for a moment the difference it would make in future ages for the prospects of republican institutions, and our civilization generally, if instead of the manly population descended from cognate nations the United States should be inhabited by the effeminate progeny of mixed races, half Indian, half negro, sprinkled with white blood. Can you devise a scheme to rescue the Spaniards of Mexico from their degradation? Beware, then, of any policy which may bring our own race to their level.

These considerations lead me naturally to the inquiry into the peculiarities of the two races, in order to find out what may be most beneficial for each. I rejoice in the prospect of universal emancipation, not only from a philanthropic point of view, but also because hereafter the physiologist and ethnographer may discuss the question of the races and advocate a discriminating policy regarding them, without seeming to support legal inequality. There is no more one-sided doctrine concerning human nature than the idea that all men are equal, in the sense of being equally capable of fostering human progress and advancing civilization, especially in the various spheres of intellectual and moral activity. If this be

so, then it is one of our primary obligations to remove every obstacle that may retard the highest development, while it is equally our duty to promote the humblest aspirations that may contribute to raise the lowest individual to a better condition in life.

The question is, then, what kind of common treatment is likely to be the best for all men, and what do the different races, taken singly, require for themselves? That legal equality should be the common boon of humanity can hardly be matter for doubt nowadays, but it does not follow that social equality is a necessary complement of legal equality. I say purposely legal equality, and not political equality, because political equality involves an equal right to every public station in life, and I trust we shall be wise enough not to complicate at once our whole system with new conflicting interests, before we have ascertained what may be the practical working of universal freedom and legal equality for two races, so different as the whites and negroes, living under one government. We ought to remember that what we know of the negro, from the experience we have had of the colored population of the North, affords but a very inadequate standard by which to judge

of the capabilities of the pure blacks as they exist in the South. We ought, further, to remember that the black population is likely at all times to outnumber the white in the Southern States. We should therefore beware how we give to the blacks rights, by virtue of which they may endanger the progress of the whites before their temper has been tested by a prolonged experience. Social equality I deem at all times impracticable, — a natural impossibility, from the very character of the negro race. Let us consider for a moment the natural endowments of the negro race as they are manifested in history on their native continent, as far as we can trace them back, and compare the result with what we know of our own destinies, in order to ascertain, within the limits of probability, whether social equality with the negro is really an impossibility.

We know of the existence of the negro race, with all its physical peculiarities, from the Egyptian monuments, several thousand years before the Christian era. Upon these monuments the negroes are so represented as to show that in natural propensities and mental abilities they were pretty much what we find them at the present day, — indolent,

playful, sensual, imitative, subservient, good-natured, versatile, unsteady in their purpose, devoted and affectionate. From this picture I exclude the character of the half-breeds, who have, more or less, the character of their white parents. Originally found in Africa, the negroes seem at all times to have presented the same characteristics wherever they have been brought into contact with the white race; as in Upper Egypt, along the borders of the Carthaginian and Roman settlements in Africa, in Senegal in juxtaposition with the French, in Congo in juxtaposition with the Portuguese, about the Cape and on the eastern coast of Africa in juxtaposition with the Dutch and the English. While Egypt and Carthage grew into powerful empires and attained a high degree of civilization; while in Babylon, Syria, and Greece were developed the highest culture of antiquity, the negro race groped in barbarism and *never originated a regular organization among themselves*. This is important to keep in mind, and to urge upon the attention of those who ascribe the condition of the modern negro wholly to the influence of slavery. I do not mean to say that slavery is a necessary condition for the organization of the negro

race. Far from it. They are entitled to their freedom, to the regulation of their own destiny, to the enjoyment of their life, of their earnings, of their family circle. But with all this nowhere do they appear to have been capable of rising, by themselves, to the level of the civilized communities of the whites, and therefore I hold that they are incapable of living on a footing of social equality with the whites in one and the same community without becoming an element of social disorder.[1]

I am not prepared to state what political privileges they are fit to enjoy now; though I have no hesitation in saying that they should be equal to other men before the law. The right of owning property, of bearing witness, of entering into contracts, of buying and selling, of choosing their own domicile, would give them ample opportunity of showing in a comparatively short time what political rights might properly and safely be granted to them in successive installments. No man has a right

[1] I fear the expression "social equality" may be misunderstood in this connection. It means here only the relations which would arise from the mixture of the two races, and thus affect the organization of society as a whole. It does not refer to any superficial or local social rules, such as sharing on common ground public conveyances, public accommodations, and the like. — ED.

to what he is unfit to use. Our own best rights have been acquired successively. I cannot, therefore, think it just or safe to grant at once to the negro all the privileges which we ourselves have acquired by long struggles. History teaches us what terrible reactions have followed too extensive and too rapid changes. Let us beware of granting too much to the negro race in the beginning, lest it become necessary hereafter to deprive them of some of the privileges which they may use to their own and our detriment. All this I urge with reference to the pure blacks of the South. As to the half-breeds, especially in the Northern States, I have already stated it to be my opinion that their very existence is likely to be only transient, and that all legislation with reference to them should be regulated with this view, and so ordained as to accelerate their disappearance from the Northern States.

Let me now sum up my answer to some of your direct questions.

1st. Is it probable that the African race will be a persistent race in this country, or will it be absorbed, diluted, and finally effaced by the white race?

I believe it will continue in the Southern States, and I hope it may gradually die out at

the North, where it has only an artificial foothold, being chiefly represented by half-breeds, who do not constitute a race by themselves.

2d. Will not the practical amalgamation fostered by slavery become more general after its abolition?

Being the result of the vices engendered by slavery, it is to be hoped that the emancipation of the blacks, by securing to them a legal recognition of their natural ties, will tend to diminish this unnatural amalgamation and lessen everywhere the number of these unfortunate half-breeds. My reason for believing that the colored population of the North will gradually vanish is founded in great degree upon the fact that that population does not increase where it exists now, but is constantly recruited by an influx from the South. The southern half-breeds feel their false position at the South more keenly than the blacks, and are more inclined to escape to the North than the individuals of purer black blood. Remove the oppression under which the colored population now suffers, and the current will at once be reversed; blacks and mulattoes of the North will seek the sunny South. But I see no cause which should check the increase of the black population in the South-

ern States. The climate is genial to them; the soil rewards the slightest labor with a rich harvest. The country cannot well be cultivated without real or fancied danger to the white man, who, therefore, will not probably compete with the black in the labors of the field, thus leaving to him an opportunity for easy and desirable support.

3d. In those sections where the blacks and mulattoes together make from seventy to eighty and even ninety per cent. of the population will there be, after the abolition of slavery, a sufficiently large influx of whites to counteract the present numerical preponderance of blacks?

To answer this question correctly we must take into consideration the mode of distribution of the white and of the colored population in the more Southern States. The whites inhabit invariably the sea-shores and the more elevated grounds, while the blacks are scattered over the lowlands. This peculiar localization is rendered necessary by the physical constitution of the country. The lowlands are not habitable in summer by the whites between sunset and sunrise. All the wealthy whites, and in the less healthy regions even the overseers, repair in the evening to the sea-

shore or to the woodlands, and return only in the morning to the plantation, except during the winter months, after the first hard frost, when the country is everywhere habitable by all. This necessarily limits the area which can be tenanted by the whites, and in some States that area is very small as compared with that habitable by the blacks. It is therefore clear that with a free black population, enjoying identical rights with the whites, these States will sooner or later become negro States, with a comparatively small white population. This is inevitable; we might as soon expect to change the laws of nature as to avert this result. I believe it may in a certain sense work well in the end. But any policy based upon different expectations is doomed to disappointment.

4th. How to prevent the whites from securing the lion's share of the labor of the blacks?

This is a question which my want of familiarity with the operations of the laboring classes prevents me from answering in a manner satisfactory to myself. Is it not possible to apply to the superintendence of the working negroes something like the system which regulates the duties of the foreman in all our manufacturing establishments?

I should like to go on and attempt to devise some scheme in conformity with the convictions I have expressed in these letters. But I have little ability in the way of organizing, and then the subject is so novel that I am not prepared to propose anything very definite.

Ever truly yours,

LOUIS AGASSIZ.

FROM DR. S. G. HOWE.

NEW YORK, *August* 18, 1863.

MY DEAR AGASSIZ, — I cannot refrain from expressing my thanks for your prompt compliance with my request, and for your two valuable letters.

Be assured I shall try to keep my mind open to conviction and to forbear forming any theory before observing a wide circle of facts. I do not know how you got the idea that I had decided in favor of anything about the future of the colored population. I have corresponded with the founders of "La Société Cosmopolite pour la fusion des races humaines" in France, — an amalgamation society, founded upon the theory that the perfect man is to be the result of the fusion of all the races upon earth. I have not, however, the honor of being a member thereof. In-

deed, I think it hardly exists. I hear, too, that several of our prominent anti-slavery gentlemen, worthy of respect for their zeal and ability, have publicly advocated the doctrines of amalgamation; but I do not know upon what grounds.

I do, indeed, hold that in this, as in other matters, we are to do the manifest right, regardless of consequences. If you ask me who is to decide what is the manifest right, I answer, that in morals, as well as in mathematics, there are certain truths so simple as to be admitted at sight as axioms by every one of common intelligence and honesty. The right to life is as clear as that two and two make four, and none dispute it. The right to liberty and to ownership of property fairly earned is just as clear to the enlightened mind as that $5 \times 6 = 30$; but the less enlightened may require to reflect about it, just as they may want concrete signs to show that five times six do really make thirty. As we ascend in numbers and in morals, the intuitive perceptions become less and less; and though the truths are there, and ought to be admitted as axiomatic, they are not at once seen and felt by ordinary minds.

Now so far as the rights of blacks and the

duties of whites are manifest to common and honest minds, so far would I admit the first and perform the second, though the heavens fall. I would not only advocate entire freedom, equal rights and privileges, and open competition for social distinction, but what now seems to me the shocking and downward policy of amalgamation. But the heavens are not going to fall, and we are not going to be called upon to favor any policy discordant with natural instincts and cultivated tastes.

A case may be supposed in which the higher race ought to submit to the sad fate of dilution and debasement of its blood, — as on an island, and where long continued wrong and suffering had to be atoned for. But this is hardly conceivable, because, even in what seems punishment and atonement, the law of harmonious development still rules. God does not punish wrong and violence done to one part of our nature, by requiring us to do wrong and violence to another part. Even Nemesis wields rather a guiding-rod than a scourge. We need take no step backward, but only aside, to get sooner into the right path.

Slavery has acted as a disturbing force in the development of our national character and

produced monstrous deformities of a bodily as well as moral nature, for it has impaired the purity and lowered the quality of the national blood. It imported Africans, and, to prevent their extinction by competition with a more vigorous race, it set a high premium on colored blood. It has fostered and multiplied a vigorous black race, and engendered a feeble mulatto breed. Many of each of these classes have drifted northward, right in the teeth of thermal laws, to find homes where they would never live by natural election. Now, by utterly rooting out slavery, and by that means alone, shall we remove these disturbing forces and allow fair play to natural laws, by the operation of which, it seems to me, the colored population will disappear from the Northern and Middle States, if not from the continent, before the more vigorous and prolific white race. It will be the duty of the statesman to favor, by wise measures, the operation of these laws and the purification and elevation of the national blood.

In the way of this is the existence of the colored population of the Northern and Middle States. Now, while we should grant to every human being all the rights we claim for ourselves, and bear in mind the cases of indi-

vidual excellence of colored people, we must, I think, admit that mulattoism is hybridism, and that it is unnatural and undesirable. It has been brought to its present formidable proportions by several causes, — mainly by slavery. Its evils are to be met and lessened as far as may be, by wise statesmanship and by enlightenment of public opinion. These may do much.

Some proclaim amalgamation as the remedy, upon the theory that by diluting black blood with white blood in larger and larger proportions, it will finally be so far diluted as to be imperceptible and will disappear. They forget that we may not do the wrong that right may come of it. They forget that no amount of diffusion will exterminate whatever exists; that a pint of ink diffused in a lake is still there, and the water is only the less pure.

Others persist that mulattoism is not and cannot be persistent beyond four generations. In other words, that like some other abnormal and diseased conditions it is self-limiting, and that the body social will be purged of it.

In the face of these and other theories, it is our duty to gather as many facts and as much knowledge as is possible, in order to throw

light upon every part of the subject; nobody can furnish more than you can.

Faithfully yours,

SAMUEL G. HOWE.[1]

The Museum and his own more immediate scientific work must naturally take precedence in any biography of Agassiz, and perhaps, for this reason, too little prominence has been given in these pages to his interest in general education, and especially in the general welfare and progress of Harvard College. He was deeply attached to the University with which he had identified himself in America. While he strained every nerve to develop his own scientific department, which had no existence at Harvard until his advent there, no one of her professors was more concerned than himself for the organization of the college as a whole. A lover of letters as well as a devotee of nature, he valued every provision for a well proportioned intellectual training. He welcomed the creation of an Academic Council for the promotion of free and

[1] In this correspondence with Dr. Howe, one or two phrases in Agassiz's letters are interpolated from a third unfinished letter, which was never forwarded to Dr. Howe. These sentences connect themselves so directly with the sense of the previous letters that it seemed worth while to add them. — ED.

frequent interchange of opinion between the different heads of departments, and, when in Cambridge, he was never absent from the meetings. He urged, also, the introduction of university lectures, to the establishment of which he largely contributed, and which he would fain have opened to all the students. He advocated the extension of the elective system, believing that while it might perhaps give a pretext for easy evasion of duty to the more inefficient and lazy students, it gave larger opportunities to the better class, and that the University should adapt itself to the latter rather than the former. "The bright students," he writes to a friend, "are now deprived of the best advantages to be had here, because the dull or the indifferent must still be treated as children."

The two following letters, from their bearing on general university questions, are not out of place here. Though occasioned by a slight misconception, they are so characteristic of the writers, and of their relation to each other, that it would be a pity to omit them.

TO RALPH WALDO EMERSON.

December 12, 1864.

My dear Emerson, — If your lecture on universities, the first of your course, has been correctly reported to me, I am almost inclined to quarrel with you for having missed an excellent chance to help me, and advance the true interests of the college. You say that Natural History is getting too great an ascendency among us, that it is out of proportion to other departments, and hint that a check-rein would not be amiss on the enthusiastic professor who is responsible for this.

Do you not see that the way to bring about a well-proportioned development of all the resources of the University is not to check the natural history department, but to stimulate all the others? not that the zoölogical school grows too fast, but that the others do not grow fast enough? This sounds invidious and perhaps somewhat boastful; but it is you and not I who have instituted the comparison. It strikes me you have not hit upon the best remedy for this want of balance. If symmetry is to be obtained by cutting down the most vigorous growth, it seems to me it would be better to have a little irregularity here and

there. In stimulating, by every means in my power, the growth of the Museum and the means of education connected with it, I am far from having a selfish wish to see my own department tower above the others. I wish that every one of my colleagues would make it hard for me to keep up with him, and there are some among them, I am happy to say, who are ready to run a race with me. Perhaps, after all, I am taking up the cudgels against you rather prematurely. If I had not been called to New Haven, Sunday before last, by Professor Silliman's funeral, I should have been present at your lecture myself. Having missed it, I may have heard this passage inaccurately repeated. If so, you must forgive me, and believe me always, whatever you did or did not say,

Ever truly your friend,

LOUIS AGASSIZ.

FROM RALPH WALDO EMERSON.

CONCORD, *December* 13, 1864.

DEAR AGASSIZ, — I pray you have no fear that I did, or can, say any word unfriendly to you or to the Museum, for both of which blessings — the cause and the effect — I daily thank Heaven! May you both increase and multiply for ages!

I cannot defend my lectures, — they are prone to be clumsy and hurried botches, — still less answer for any report, — which I never dare read; but I can tell you the amount of my chiding. I vented some of the old grudge I owe the college now for forty-five years, for the cruel waste of two years of college time on mathematics without any attempt to adapt, by skillful tutors, or by private instruction, these tasks to the capacity of slow learners. I still remember the useless pains I took, and my serious recourse to my tutor for aid which he did not know how to give me. And now I see to-day the same indiscriminate imposing of mathematics on all students during two years, — ear or no ear, you shall all learn music, — to the waste of time and health of a large part of every class. It is both natural and laudable in each professor to magnify his department, and to seek to make it the first in the world if he can. But of course this tendency must be corrected by securing in the constitution of the college a power in the head (whether singular or plural) of coördinating all the parts. Else, important departments will be overlaid, as in Oxford and in Harvard, natural history was until now. Now, it looks as if natural history would ob-

tain in time to come the like predominance as mathematics have here, or Greek at Oxford. It will not grieve me if it should, for we are all curious of nature, but not of algebra. But the necessity of check on the instructors in the head of the college, I am sure you will agree with me, is indispensable. You will see that my allusion to naturalists is only incidental to my statement of my grievance.

But I have made my letter ridiculously long, and pray you to remember that you have brought it on your own head. I do not know that I ever attempted before an explanation of any speech.

Always with entire regard yours,

R. W. Emerson.

At about this time, in September, 1864, Agassiz made an excursion into Maine, partly to examine the drift phenomena on the islands and coast of that State, and partly to study the so-called "horse-backs." The journey proved to be one of the most interesting he had made in this country with reference to local glacial phenomena. Compass in hand, he followed the extraordinary ridges of morainic material lying between Bangor and Katahdin, to the Ebeene Mountains, at the foot

of which are the Katahdin Iron Works. Returning to Bangor, he pursued, with the same minute investigation, the glacial tracks and erratic material from that place to the sea-coast and to Mount Desert. The details of this journey and its results are given in one of the papers contained in the second volume of his "Geological Sketches." In conclusion, he says; "I suppose these facts must be far less expressive to the general observer than to one who has seen this whole set of phenomena in active operation. To me they have been for many years so familiar in the Alpine valleys, and their aspect in those regions is so identical with the facts above described, that paradoxical as the statement may seem, the presence of the ice is now an unimportant element to me in the study of glacial phenomena; no more essential than is the flesh to the anatomist who studies the skeleton of a fossil animal."

This journey in Maine, undertaken in the most beautiful season of the American year, when the autumn glow lined the forest roads with red and gold, was a great refreshment to Agassiz. He had been far from well, but he returned to his winter's work invigorated and with a new sense of hope and courage.

CHAPTER XXI.

1865–1868 : ÆT. 58–61.

Letter to his Mother announcing Journey to Brazil. — Sketch of Journey. — Kindness of the Emperor. — Liberality of the Brazilian Government. — Correspondence with Charles Sumner. — Letter to his Mother at Close of Brazil Journey. — Letter from Martius concerning Journey in Brazil. — Return to Cambridge. — Lectures in Boston and New York. — Summer at Nahant. — Letter to Professor Peirce on the Survey of Boston Harbor. — Death of his Mother. — Illness. — Correspondence with Oswald Heer. — Summer Journey in the West. — Cornell University. — Letter from Longfellow.

THE next important event in the life of Agassiz, due in the first instance to his failing health, which made some change of scene and climate necessary, is best announced by himself in the following letter.

TO HIS MOTHER.

CAMBRIDGE, *March* 22, 1865.

DEAR MOTHER, — You will shed tears of joy when you read this, but such tears are harmless. Listen, then, to what has happened. A few weeks ago I was thinking how I should

employ my summer. I foresaw that in going to Nahant I should not find the rest I need after all the fatigue of the two last years, or, at least, not enough of change and relaxation. I felt that I must have new scenes to give me new life. But where to go and what to do?

Perhaps I wrote you last year of the many marks of kindness I have received from the Emperor of Brazil, and you remember that at the time of my début as an author, my attention was turned to the natural history of that country. Lately, also, in a course of lectures at the Lowell Institute, I have been led to compare the Alps, where I have passed so many happy years, with the Andes, which I have never seen. In short, the idea came to me gradually, that I might spend the summer at Rio de Janeiro, and that, with the present facilities for travel, the journey would not be too fatiguing for my wife. . . . Upon this, then, I had decided, when most unexpectedly, and as the consummation of all my wishes, my pleasure trip was transformed into an important scientific expedition for the benefit of the Museum, by the intervention of one of my friends, Mr. Nathaniel Thayer. By chance I met him a week ago in Boston. He laughed at me a little about my roving disposition,

and then asked me what plans I had formed for the Museum, in connection with my journey. I answered that, thinking especially of my health, I had provided only for the needs of myself and my wife during an absence of six or eight months. Then ensued the following conversation.

"But, Agassiz, that is hardly like you; you have never been away from Cambridge without thinking of your Museum."

"True enough; but I am tired, — I need rest. I am going to loaf a little in Brazil."

"When you have had a fortnight of that kind of thing you will be as ready for work as ever, and you will be sorry that you have not made some preparation to utilize the occasion and the localities in the interest of the Museum."

"Yes, I have some such misgiving; but I have no means for anything beyond my personal expenses, and it is no time to ask sacrifices from any one in behalf of science. The country claims all our resources."

"But suppose some one offered you a scientific assistant, all expenses paid, what would you say?"

"Of that I had never thought."

"How many assistants could you employ?"

"Half a dozen."

"And what would be the expense of each one?"

"I suppose about twenty-five hundred dollars; at least, that is what I have counted upon for myself."

After a moment's reflection he resumed: —

"If it suits you then, Agassiz, and interferes in no way with the plans for your health, choose your assistants among the employees of your Museum or elsewhere, and I will be responsible for all the scientific expenses of the expedition." . . .

My preparations are made. I leave probably next week, from New York, with a staff of assistants more numerous, and, I think, as well chosen, as those of any previous undertaking of the kind.[1]

. . . All those who know me seem to have combined to heighten the attraction of the journey, and facilitate it in every respect. The Pacific Mail Steamship Company has invited me to take passage with my whole party on their fine steamer, the Colorado. They will take us, free of all expense, as far as Rio

[1] Beside the six assistants provided for by Mr. Thayer, there were a number of young volunteer aids who did excellent work on the expedition.

de Janeiro, — an economy of fifteen thousand francs at the start. Yesterday evening I received a letter from the Secretary of the Navy, at Washington, desiring the officers of all vessels of war stationed along the coasts I am to visit, to give me aid and support in everything concerning my expedition. The letter was written in the kindest terms, and gratified me the more because it was quite unsolicited. I am really touched by the marks of sympathy I receive, not only from near friends, but even from strangers. . . . I seem like the spoiled child of the country, and I hope God will give me strength to repay in devotion to her institutions and to her scientific and intellectual development, all that her citizens have done for me.

I am forgetting that you will be anxious to know what special work I propose to do in the interest of science in Brazil. First, I hope to make large collections of all such objects as properly belong in a Museum of Natural History, and to this end I have chosen from among the employees of our Museum one representative from each department. My only regret is that I must leave Alex. in Cambridge to take care of the Museum itself. He will have an immense amount of work to do, for

I leave him only six out of our usual staff of assistants. In the second place, I intend to make a special study of the habits, metamorphoses, anatomy, etc., of the Amazonian fishes. Finally, I dream sometimes of an ascension of the Andes, if I do not find myself too old and too heavy for climbing. I should like to see if there were not also large glaciers in this chain of mountains, at the period when the glaciers of the Alps extended to the Jura. . . . But this latter part of my plan is quite uncertain, and must depend in great degree upon our success on the Amazons. Accompanied as I am with a number of *aides naturalistes*, we ought to be able among us to bring together large collections, and even to add duplicates, which I can then, on my return, distribute to the European Museums, in exchange for valuable specimens.

We leave next week, and I hope to write you from Rio a letter which will reach you about the date of my birthday. A steamer leaves Brazil once a month for England. If my arrival coincides with her departure you shall not be disappointed in this.

With all my heart,

Your Louis.

The story of this expedition has been told in the partly scientific, partly personal diary published after Agassiz's return, under the title of "A Journey in Brazil," and therefore a full account of it here would be mere repetition. He was absent sixteen months. The first three were spent in Rio de Janeiro, and in excursions about the neighborhood of her beautiful bay and the surrounding mountains. For greater efficiency and promptness he divided his party into companies, each working separately, some in collecting, others in geological surveys, but all under one combined plan of action.

The next ten months were passed in the Amazonian region. This part of the journey had the charm of purely tropical scenery, and Agassiz, who was no less a lover of nature than a naturalist, enjoyed to the utmost its beauty and picturesqueness. Much of the time he and his companions were living on the great river itself, and the deck of the steamer was by turns laboratory, dining-room, and dormitory. Often, as they passed close under the banks of the river, or between the many islands which break its broad expanse into narrow channels, their improvised working room was overshadowed by the lofty wall

of vegetation, which lifted its dense mass of trees and soft drapery of vines on either side. Still more beautiful was it when they left the track of the main river for the water-paths hidden in the forest. Here they were rowed by Indians in "montarias," a peculiar kind of boat used by the natives. It has a thatched hood at one end for shelter from rain or sun. Little sun penetrates, however, to the shaded "igarapè" (boat-path), along which the montaria winds its way under a vault of green. When traveling in this manner, they stopped for the night, and indeed sometimes lingered for days, in Indian settlements, or in the more secluded single Indian lodges, which are to be found on the shores of almost every lake or channel. In this net-work of fresh waters, threading the otherwise impenetrable woods, the humblest habitation has its boat and landing-place. With his montaria and his hammock, his little plantation of bananas and mandioca, and the dwelling, for which the forest about him supplies the material, the Amazonian Indian is supplied with all the necessities of life.

Sometimes the party were settled, for weeks at a time, in more civilized fashion, in the towns or villages on the banks of the main

river, or its immediate neighborhood, at Manaos, Ega, Obydos, and elsewhere. Wherever they sojourned, whether for a longer or a shorter time, the scientific work went on uninterruptedly. There was not an idle member in the company.

From the time he left Rio de Janeiro, Agassiz had the companionship of a young Brazilian officer of the engineer corps, Major Coutinho. Thoroughly familiar with the Amazons and its affluents, at home with the Indians, among whom he had often lived, he was the pearl of traveling companions as well as a valuable addition to the scientific force. Agassiz left the Amazonian valley in April, and the two remaining months of his stay in Brazil were devoted to excursions along the coast, especially in the mountains back of Ceara, and in the Organ mountains near Rio de Janeiro.

From beginning to end this journey fulfilled Agassiz's brightest anticipations. Mr. Thayer, whose generosity first placed the expedition on so broad a scientific basis, continued to give it his cordial support till the last specimen was stored in the Museum. The interest taken in it by the Emperor of Brazil, and the liberality of the government toward it, also facilitated all Agassiz's aims

and smoothed every difficulty in the path. On starting he had set before himself two subjects of inquiry. These were, first, the fresh-water fauna of Brazil, of the greater interest to him, because of the work on the Brazilian Fishes, with which his scientific career had opened; and second, her glacial history, for he believed that even these latitudes must have been, to a greater or less degree, included in the ice-period. The first three months spent in Rio de Janeiro and its environs gave him the key to phenomena connected with both these subjects, and he followed them from there to the head-waters of the Amazons, as an Indian follows a trail. The distribution of life in the rivers and lakes of Brazil, the immense number of species and their local circumscription, as distinct faunæ in definite areas of the same water-basin, amazed him; while the character of the soil and other geological features confirmed him in his preconceived belief that the glacial period could not have been less than cosmic in its influence. He was satisfied that the tropical, as well as the temperate and arctic regions, had been, although in a less degree, fashioned by ice.

Just before leaving the United States he received a letter of friendly farewell from

Charles Sumner, and his answer, written on the Rio Negro, gives some idea of the conditions under which he traveled, and of the results he had obtained. As the letters explain each other, both are given here.

FROM CHARLES SUMNER.

WASHINGTON, *March* 20, 1865.

MY DEAR AGASSIZ, — It is a beautiful expedition that you are about to commence, — in contrast with the deeds of war. And yet you are going forth to conquer new realms, and bring them under a sway they have not yet known. But science is peaceful and bloodless in her conquests. May you return victorious! I am sure you will. Of course you will see the Emperor of Brazil, whose enlightened character is one of the happy accidents of government. . . . You are a naturalist; but you are a patriot also. If you can take advantage of the opportunities which you will surely enjoy, and plead for our country, to the end that its rights may be understood, and the hardships it has been obliged to endure may be appreciated, you will render a service to the cause of international peace and good-will.

You are to have great enjoyment. I imagine you already very happy in the scenes be-

fore you. I, too, should like to see Nature in her most splendid robes; but I must stay at home and help keep the peace. Good-by — Bon voyage!

Ever sincerely yours,

CHARLES SUMNER.

TO CHARLES SUMNER.

RIO NEGRO; ON BOARD THE BRAZILIAN WAR STEAMER IBICUHY, *December* 26, 1865.

MY DEAR SUMNER, — The heading of these lines tells a long and interesting story. Here I am, sailing on the Rio Negro, with my wife and a young Brazilian friend, provided with all the facilities which modern improvements, the extraordinary liberality of the Brazilian government, and the kindness of our commander can bestow, and pursuing my scientific investigations with as much ease as if I were in my study, or in the Museum at Cambridge, — with this enormous difference, that I am writing on deck, protected by an awning from the hot sun, and surrounded by all the luxuriance of the richest tropical vegetation.

The kind reception I met at the hands of the emperor on my arrival at Rio has been followed by every possible attention and mark of good-will toward me personally, but usually

tendered in such a way as to show that an expression of cordiality toward the United States was intended also in the friendly feeling with which everything was done to facilitate my researches. In the first place, the emperor gave me as a traveling companion an extremely intelligent and well-educated Brazilian, the man of all others whom I should have chosen had I been consulted beforehand; and for the six months during which we have been on our journey here, I have not been able to spend a dollar except for my personal comfort, and for my collections. All charges for transportation of persons and baggage in public conveyances, as well as for specimens, have everywhere been remitted by order of the government. This is not all; when we reached Parà the Brazilian Steamship Company placed a steamer at my disposal, that I might stop where I pleased on the way, and tarry as long as I liked instead of following the ordinary line of travel. In this way I ascended the Amazons to Manaos, and from there, by the ordinary steamer, reached the borders of Peru, making prolonged stays at Manaos and at Ega, and sending out exploring parties up the Javary, the Jutay, the Ica, etc. On my return to Manaos, at the junction of the Rio Negro and the

Amazons, I found the Ibicuhy awaiting me with an order from the Minister of Public Works, placing her at my disposal for the remainder of my stay in the waters of the Amazons.

The Ibicuhy is a pretty little war steamer of 120 horse power, carrying six thirty-two pound guns. On board of her, and in company with the President of the Province, I have already visited that extraordinary network of river anastomoses and lakes, stretching between the river Madeira and the Amazons to the river Tapajos, and now I am ascending the Rio Negro, with the intention of going up as far as the junction of the Rio Branco with the Rio Negro. That the Brazilian government should be able and willing to offer such facilities for the benefit of science, during a time of war, when all the resources of the nation are called upon in order to put an end to the barbarism of Paraguay, is a most significant sign of the tendencies prevailing in the administration. There can be no doubt that the emperor is the soul of the whole. This liberality has enabled me to devote all my resources to the making of collections, and the result of my researches has, of course, been proportionate to the facilities I

have enjoyed. Thus far, the whole number of fishes known from the Amazons has amounted to a little over one hundred, counting everything that may exist from these waters, in the Jardin des Plantes, the British Museum, the museums of Munich, Berlin, Vienna, etc.; while I have collected and now hold, in good state of preservation, fourteen hundred and forty-two species, and may get a few hundred more before returning to Parà. I have so many duplicates that I may make every other museum tributary to ours, so far as the fresh-water animals of Brazil are concerned. This may seem very unimportant to a statesman. But I am satisfied that it affords a standard by which to estimate the resources of Brazil, as they may be hereafter developed. The basin of the Amazons is another Mississippi, having a tropical climate, tempered by moisture. Here is room for a hundred million happy human beings.

Ever truly your friend,

L. AGASSIZ.

The repose of the return voyage, after sixteen months of such uninterrupted work, and of fresh impressions daily crowding upon each other, was most grateful to Agassiz. The

summary of this delightful journey may close as it began with a letter to his mother.

At Sea, *July* 7, 1866.

Dear Mother, — When you receive this letter we shall be, I hope, at Nahant, where our children and grandchildren are waiting for us. To-morrow we shall stop at Pernambuco, where I shall mail my letter to you by a French steamer.

I leave Brazil with great regret. I have passed nearly sixteen months in the uninterrupted enjoyment of this incomparable tropical nature, and I have learned many things which have enlarged my range of thought, both concerning organized beings and concerning the structure of the earth. I have found traces of glaciers under this burning sky; a proof that our earth has undergone changes of temperature more considerable than even our most advanced glacialists have dared to suggest. Imagine, if you can, floating ice under the equator, such as now exists on the coasts of Greenland, and you will probably have an approximate idea of the aspect of the Atlantic Ocean at that epoch.

It is, however, in the basin of the Amazons especially, that my researches have been crowned

with an unexpected success. Spix and Martius, for whose journey I wrote, as you doubtless remember, my first work on fishes, brought back from there some fifty species, and the sum total known now, taking the results of all the travelers who have followed up the inquiry, does not amount to two hundred. I had hoped, in making fishes the special object of my researches, to add perhaps a hundred more. You will understand my surprise when I rapidly obtained five or six hundred, and finally, on leaving Parà, brought away nearly two thousand, — that is to say, ten times more than were known when I began my journey.[1] A great part of this success is due to the unusual facilities granted me by the Brazilian government. . . . To the Emperor of Brazil I owe the warmest gratitude. His kindness to me has been beyond all bounds. . . . He even made for me, while he was with the army last summer, a collection of fishes from the

[1] This estimate was made in the field when close comparison of specimens from distant localities was out of the question. The whole collection has never been worked up, and it is possible that the number of new species it contains, though undoubtedly greatly in excess of those previously known from the Amazons, may prove to be less than was at first supposed. — Ed.

province of Rio Grande du Sud. This collection would do honor to a professional naturalist. . . .

Good-by, dear mother.

With all my heart,

Your Louis.

The following letter from old Professor Martius in Munich, of uncertain date, but probably in answer to one of March, 1866, is interesting, as connecting this journey with his own Brazilian expedition almost half a century before.

FROM PROFESSOR MARTIUS.

February 26, 1867.

My dear Friend, — Your letter of March 20th last year was most gratifying to me as a token of your affectionate remembrance. You will easily believe that I followed your journey on the Amazons with the greatest interest, and without any alloy of envy, though your expedition was undertaken forty years later than mine, and under circumstances so much more favorable. Bates, who lived for years in that country, has borne me witness that I was not wanting in courage and industry during an exploration which lasted eleven months; and I therefore believe that you also, in reviewing

on the spot my description of the journey, will not have passed an unfavorable judgment. Our greatest difficulty was the small size of our boat which was so weak as to make the crossing of the river always dangerous. I shall look forward with great pleasure to the more detailed account of your journey, and also the plan of your route, which I hope you will send me. Can you tell me anything about the human skeletons at the Rio St. Antonio in St. Paul? I am very glad to know that you have paid especial attention to the palms, and I entreat you to send me the essential parts of every species which you hold to be new, because I wish to work out the palms for the Flora Brasiliensis this year. I wish I might find among them some new genus or species, which then should bear your name.

Do you intend to publish an account of your journey, or shall you confine yourself entirely to a report on your observations on Natural History? With a desire to explain the numerous names of animals, plants, and places, which are derived from the Tupèe language, I have studied it for years that I might be able to use it fluently. Perhaps you have seen my "Glossaria lignareus brasiliensium." It contains also 1150 names of animals. To this work belong, likewise, my ethnographical

contributions, of which forty-five sheets are already printed, to be published I hope next year. I am curious to hear your geological conclusions. I am myself inclined to the belief that men existed in South America previous to the latest geological catastrophes. As you have seen so many North American Indians, you will be able to give interesting explanations of their somatic relations to the South American Indians. Why could you not send me, as secretary of the mathematical and physical section, a short report of your principal results? It would then be printed in the report of our meetings, which, as the forerunner of other publications, could hardly fail to be agreeable to you. You no doubt see our friend Asa Gray occasionally. Remember me cordially to him, and tell him I look eagerly for an answer to my last letter. The year 'sixty-six has taken from us many eminent botanists, Gusone, Mettenius, Von Schlechtendal, and Fresenius. I hear but rarely from our excellent friend Alexander Braun. He does not resist the approach of old age so well as you, my dear friend. You are still the active naturalist, fresh and well preserved, to judge by your photograph. Thank you for it; I send mine in return. My wife still holds in warm remembrance the days when you, a bright,

pleasant young fellow, used to come and see us, — what a long stretch of time lies between. Much is changed about me. Of former friends only Kobell and Vogel remain; Zuccarini, Wagner, Oken, Schelling, Sieber, Fuchs, Walther, — all these have gone home. All the pleasanter is it that you, on the other side of the ocean, think sometimes of your old friend, to whom a letter from you will be always welcome. Remember me to your family, though I am not known to them. May the present year bring you health, cheerfulness, and the full enjoyment of your great and glorious success.

With warm esteem and friendship, always yours,

MARTIUS.

Agassiz arrived in Cambridge toward the end of August, 1866. After the first excitement of meeting family and friends was over, he took up his college and museum work again. He had left for Brazil at the close of a course before the Lowell Institute, and his first public appearance after his return was on the same platform. The rush for tickets was far in excess of the supply, and he was welcomed with the most ardent enthusiasm. It continued unabated to the close, although the

lectures borrowed no interest from personal adventure or incidents of travel, but dealt almost wholly with the intellectual results and larger scientific generalizations growing out of the expedition. Later in the winter he gave a course also at the Cooper Institute, in New York, which awakened the same interest and drew crowds of listeners. The resolution offered by Bancroft, the historian, at the close of the course, gives an idea of its character, and coming from such a source, may not unfitly be transcribed here.

Resolved, That the thanks of this great assembly of delighted hearers be given to the illustrious Professor Agassiz, for the fullness of his instruction, for the clearness of his method of illustration, for his exposition of the idea as antecedent to form; of the superiority of the undying, original, and eternal force over its transient manifestations; for happy hours which passed too rapidly away; for genial influences of which the memory will last through our lives.

All his leisure hours during the winter of 1867 were given to the review and arrangement of the great collections he had brought home.

TO SIR PHILIP DE GREY EGERTON.

MUSEUM OF COMPARATIVE ZOÖLOGY,
CAMBRIDGE, MASS., *March* 26, 1867.

. . . I know you will be pleased to hear that I have returned to the study of fishes, and that I am not likely to give it up again for years to come. My success in collecting in the Amazons has been so unexpected that it will take me years to give an account of what I have found, and I am bound to show that the strange statements that have gone abroad are strictly correct. Yes, I have about eighteen hundred new species of fishes from the basin of the Amazons! The collection is now in Cambridge, for the most part in good preservation. It suggests at once the idea that either the other rivers of the world have been very indifferently explored, or that tropical America nourishes a variety of animals unknown to other regions. In this dilemma it would be worth while to send some naturalist to investigate the Ganges or the Bramaputra, or some of the great Chinese rivers. Can it not be done by order of the British government?

Please send me whatever you may publish upon the fossil fishes in your possession. I

frequently sigh for another session in your museum, and it is not improbable that I shall solicit an invitation from you in a few years, in order to revise my views of the whole subject in connection with what I am now learning of the living fishes. By the way, I have eleven hundred colored drawings of the species of Brazil made from life by my old friend Burkhardt, who accompanied me on this journey.

My recent studies have made me more adverse than ever to the new scientific doctrines which are flourishing now in England. This sensational zeal reminds me of what I experienced as a young man in Germany, when the physio-philosophy of Oken had invaded every centre of scientific activity; and yet, what is there left of it? I trust to outlive this mania also. As usual, I do not ask beforehand what you think of it, and I may have put my hand into a hornet's nest; but you know your old friend Agass., and will forgive him if he hits a tender spot. . . .

The summer of 1867 was passed very tranquilly at his Nahant laboratory, in that quiet work with his specimens and his microscope which pleased him best. The following letter

to Professor Benjamin Peirce, who was then Superintendent of the Coast Survey, shows, however, his unfailing interest in the bearing of scientific researches on questions of public utility.

TO PROFESSOR PEIRCE, SUPERINTENDENT OF THE COAST SURVEY.

NAHANT, *September* 11, 1867.

DEAR SIR, — Far from considering your request a tax upon my time, it gives me the greatest pleasure to have an opportunity of laying before you some statements and reflections, which I trust may satisfy you that geology and natural history can be made subservient to the great interests of a civilized community, to a far greater extent than is generally admitted.

The question of the harbor of Boston, for instance, has a geological and zoölogical side, thus far only indirectly considered. In order to ascertain whence the materials are derived which accumulate in the harbor, the shores ought to be studied geologically with a kind of accuracy and minuteness, never required by geological surveys made for economical purposes. The banks of the harbor, wherever it is not rock-bound, consist of drift, which it-

self rests upon the various rock formations of the district. Now this drift, as I have ascertained, formerly extended many miles beyond our present shores, and is still slowly washed away by the action of tides, winds, and currents. Until you know with precision the mineralogical composition of the drift of the immediate vicinity, so accurately indeed as to be able to recognize it in any new combination into which it may be brought when carried off by the sea, all your examination of soundings may be of little use. Should it, however, be ascertained that the larger amount of loose material spreading over the harbor is derived from some one or other of the drift islands in the bay, the building of sea-walls to stop the denudation may be of greater and more immediate use than any other operation. Again, it is geologically certain that all the drift islands of the harbor have been formed by the encroachment of the sea upon a sheet of drift, which once extended in unbroken continuity from Cape Ann to Cape Cod and farther south. This sheet of drift is constantly diminishing, and in centuries to come, which, notwithstanding the immeasurable duration of geological periods, may be reached, I trust, while the United States still remains a flour-

ishing empire, it will be removed still further; so far indeed, that I foresee the time when the whole peninsula of Cape Cod shall disappear. Under these circumstances, it is the duty of a wise administration to establish with precision the rate and the extent of this destruction, that the coming generations may be forewarned. In connection with this I would advise the making of a thorough survey of the harbor, to ascertain the extent of rock surface and of drift, and the relative position of the two, with maps to show their relations to the different levels of the sea, whereby the unequal action of the tides upon the various beaches may be estimated.

The zoölogical side of the question relates to the amount of loose materials accumulating in consequence of the increase of animal and vegetable life, especially of those microscopic beings which, notwithstanding their extraordinary minuteness, form in course of time vast deposits of solid materials. Ehrenberg has shown that the harbor of Wismar, on the Prussian coast of the Baltic, is filling, not in consequence of the accumulation of inorganic sediments, but by the rapid increase and decay of innumerable animalcules. To what extent such deposits may accumulate has also been shown

by Ehrenberg, who ascertained, many years ago, that the city of Berlin rests upon a deposit of about eighteen feet in thickness, consisting almost exclusively of the solid parts of such microscopic beings. These two cases may suffice to show how important may be a zoölogical investigation of the harbor deposits.

I need hardly add that the deposits floated into the harbor, by the numerous rivers and creeks which empty into it, ought to be investigated with the same care and minuteness as the drift materials. This investigation should also include the drainage of the city.

But this is only a small part of the application I would recommend to be made of geological and zoölogical knowledge, to the purposes of the Coast Survey. The reefs of Florida are of the deepest interest, and the mere geodetic and hydrographic surveys of their whole range would be far from exhausting the subject. It is my deliberate opinion that the great reefs of Florida should be explored with as much minuteness and fullness as the Gulf Stream, and that the investigation will require as much labor as has thus far been bestowed on the Gulf Stream. Here again geological and zoölogical knowledge is

indispensable to the completion of the work. The reef is formed mainly by the accumulation of solid materials from a variety of animals and a few plants. The relations of these animals and plants to one another while alive, in and upon the reef, ought to be studied more fully than has been the case heretofore, in order to determine with certainty the share they have in the formation of these immense submarine walls so dangerous to navigation. The surveys, as they have been made thus far, furnish only the necessary information concerning the present form and extent of the reef. But we know that it is constantly changing, increasing, enlarging, spreading, rising in such a way and at such a rate, that the surveys of one century become insufficient for the next. A knowledge of these changes can only be obtained by a naturalist, familiar with the structure and mode of growth of the animals. The survey I made about fifteen years ago, at the request of your lamented predecessor, could only be considered as a reconnaissance, in view of the extent and importance of the work. I would, therefore, recommend you to organize a party specially detailed to carry on these investigations in connection with, and by the side of,

the regular geodetic and hydrographic survey. Here, also, would geological knowledge be of great advantage to the explorer. In confirmation of my recommendation I need only remind you of a striking fact in the history of our science. More than thirty years ago, before Dana and Darwin had published their beautiful investigations upon the coral reefs, a pupil of mine, the late Armand Gressly, had traced the structure and mode of growth of coral reefs and atolls in the Jura mountains, thus anticipating, by a geological investigation, results afterward obtained by dredging in the ocean. The structure of the reefs of our shores is, therefore, more likely to be fully understood by one who is entirely familiar with zoölogy and geology than by a surveyor who has no familiarity with either of these sciences.

There is another reason why I would urge upon you the application of natural sciences to the work of the survey. The depth of the ocean is a great obstacle to a satisfactory exploration of its bottom. But we know now that nearly all dry land has been sea bottom before it was raised above the level of the water. This is at least the case with all the stratified rocks and aqueous deposits form-

ing part of the earth's crust. Now it would greatly facilitate the study of the bottom of the sea if, after ascertaining by soundings the general character of the bottom in any particular region, corresponding bottoms on dry land were examined, so that by a comparison of the one with the other, both might be better understood. The shoals of the southern coast of Massachusetts have been surveyed, and their position is now known with great accuracy; but their internal structure, their mode of formation, is only imperfectly ascertained, owing to the difficulty of cutting into them and examining *in situ* the materials of which they are composed. Nothing, on the contrary, is easier than to explore the structure or composition of drift hills which are cut through by all our railroad tracks. Now the shoals and rips of Nantucket have their counterparts on the main-land; and even along the shores of Boston Harbor, in the direction of Dorchester and Milton, such shoals may be examined, far away from the waters to which they owe their deposits. Here, then, is the place to complete the exploration, for which soundings and dredgings give only imperfect information.

I need not extend these remarks further in

order to satisfy you of the importance of geological and zoölogical researches in connection with the regular operations of the Coast Survey. Permit me, however, to add a few words upon some points which, as it seems to me, belong legitimately to the Coast Survey, and to which sufficient attention has not yet been paid. I allude, first, to the salt marshes of our shores, their formation and uses, as well as their gradual disappearance under the advance of the sea; second, to the extended low islands in the form of reefs along the coast of the Southern States, the bases of which may be old coral reefs; third, the form of all our estuaries, which has resulted from the conflict of the sea with the drift formation, and is therefore, in a measure, a geological problem; fourth, the extensive deposits of foraminifera along the coast, which ought to be compared with the deposits of tripoli found in many tertiary formations; fifth, the general form and outline of our continent, with all its indentations, which are due to their geological structure. Indeed, the shore everywhere is the result of the conflict of the ocean with the rock formation of the land, and therefore as much a question for geology as geodesy to answer.

Should the preceding remarks induce you to carry my suggestions into practical operation, be assured that it will at all times give me the greatest pleasure to contribute to the success of your administration, not only by advice, but by actual participation in your work whenever that is wanted. The scientific men of America look to you for the publication of the great results already secured by the Coast Survey, well knowing that this national enterprise can only be benefited by the high-minded course which has at all times marked your intellectual career.

Ever truly your friend,

L. AGASSIZ.

This year closed for Agassiz with a heavy sorrow. His mother's health had been failing of late, and November brought the news of her death. Separated though they were, there had never been any break in their intercourse. As far as he could, he kept her advised of all his projects and undertakings, and his work was no less interesting to her when the ocean lay between them than when he could daily share it with her. She had an unbounded sympathy with him in the new ties he had formed in this country, and seemed indeed as

intimately allied with his later life here as with its earlier European portion.

His own health, which had seemed for a time to have regained the vigor of youth, broke down again in the following spring, and an attack about the region of the heart disabled him for a number of weeks. To this date belongs a short correspondence between Agassiz and Oswald Heer. Heer's work on the Fossil Flora of the Arctics had recently appeared, and a presentation copy from him reached Agassiz as he was slowly regaining strength after his illness, although still confined to the house. It could not have come at a happier moment, for it engrossed him completely, and turned his thoughts away from the occupations which he was not yet allowed to resume. The book had a twofold interest for him: although in another branch of science, it was akin to his own earlier investigations, inasmuch as it reconstructed the once rich flora of the polar regions as he himself had reconstructed the fauna of past geological times; it clothed their frozen fields with forests as he had sheeted now fertile lands with ice. In short, it appealed powerfully to the imagination, and no child in the tedious hours of convalescence was ever more beguiled by a

story-book than he by the pictures which this erudite work called up.

AGASSIZ TO OSWALD HEER.

CAMBRIDGE, *May* 12, 1868.

MY HONORED COLLEAGUE, — Your beautiful book on the Fossil Arctic Flora reached me, just as I was recovering from a tedious and painful illness. I could, therefore, take it in hand at once, and have been delighted with it. You give a captivating picture of the successive changes which the Arctic regions have undergone. No work could be more valuable, either as a means of opening recent investigations in Paleontology to the larger public, or of advancing science itself. If I can find the time I mean to prepare an abridgment in popular form for one of our reviews. Meantime I have written to Professor Henry, Superintendent of the Smithsonian Institution at Washington, that he should subscribe for a number of copies to be distributed among less wealthy establishments. I hope he will do this, and I shall continue to urge it, since my friendly relations with him give me a right so to do. I have, moreover, written to the directors of various prominent institutions, in order that your work, so far as is possible for works

of that kind, may become known in the United States, and reach such persons as would naturally be interested in it. . . .

With friendly remembrance, yours always,

LOUIS AGASSIZ.

The answer is some months later in date, but is given here for its connection.

FROM OSWALD HEER.

ZURICH, *December* 8, 1868.

MY HONORED FRIEND, — Your letter of last May gave me the greatest pleasure, and I should have answered it earlier had I not heard that you had gone to the Rocky Mountains, and supposed, therefore, that my letter would hardly find you at home again before the late autumn. I will delay writing no longer, — the more so because I have received, through the Smithsonian Institution, your great work on the Natural History of the United States. Valuable as it is in itself, it has a double attraction for me as the gift of the author. Accept my warm thanks. It will always be to me a token of your friendly regard. It gave me great satisfaction to know that my Fossil Arctic Flora had met with your approval. Since then many new facts have

come to light tending to confirm my results. The Whymper Expedition brought to England a number of fossil plants, which have been sent to me for examination. I found eighty species, of which thirty-two from North Greenland are new, so that we now know 137 species of Miocene plants from North Greenland (70° N. lat). It was a real delight to me to find the fruit cup of the Castanea [chestnut] inclosing three seeds (three Kastanica) and covered with prickles like the Castanea vesca; and, furthermore, I was able to prove by the flowers, which were preserved with the fruit, that the supposition given in the Arctic Flora (p. 106) was correct; namely, that the leaves of the Fagus castaneafolia Ung. truly belong to a Castanea. As several fruits are contained in one fruit cup, this Miocene Castanea must have been nearer to the European species (C. vesca) than to the American Castanea (the C. pumila Micha). The leaves have been drawn in the Flora Arctica, and are also preserved in the Whymper collection.

I have received very beautiful and large leaves of the Castanea which I have called C. Ungeri, from Alaska. I am now occupied in working up this fossil Alaskan flora; the plants are in great part drawn, and contain

magnificent leaves. The treatise will be published by the Swedish Academy in Stockholm; I hope to send you a copy a few months hence. This flora is remarkable for its resemblance to the European Miocene flora. The liquid amber, as well as several poplars and willows, cannot be distinguished from those of Oeningen; the same is true of an Elm, a Caspinus, and others. As Alaska now belongs to the United States, it is to be hoped that these collecting stations, which have already furnished such magnificent plants, will be farther ransacked. . . . Hoping that you have returned safely from your journey, and that these lines may find you well, I remain, with cordial greeting, Sincerely yours,

OSWALD HEER.

Shortly after Agassiz's recovery, in July, 1868, he was invited by Mr. Samuel Hooper to join a party of friends, tired members of Congress and business men, on an excursion to the West, under conditions which promised not only rest and change, but an opportunity for studying glacial phenomena over a broad region of prairie and mountain which Agassiz had never visited. They were to meet at Chicago, keep on from there to St. Paul, and

down the Mississippi, turning off through Kansas to the eastern branch of the Pacific Railroad, at the terminus of which they were to meet General Sherman with ambulances and an escort for conveyance across the country to the Union Pacific Railroad, returning then by Denver, Utah, and Omaha, and across the State of Iowa to the Mississippi once more. This journey was of great interest to Agassiz, and its scientific value was heightened by a subsequent stay of nearly two months at Ithaca, N. Y., on his return. Cornell University was then just opened at Ithaca, and he had accepted an appointment as non-resident professor, with the responsibility of delivering annually a course of lectures on various subjects of natural history. New efforts in behalf of education always attracted him, and this drew him with an even stronger magnet than usual, involving as it did an untried experiment — the attempt, namely, to combine the artisan with the student, manual labor with intellectual work. The plan was a generous one, and stimulated both pupils and teachers. Among the latter none had greater sympathy with the high ideal and broad humanity of the undertaking than Agassiz.[1]

[1] Very recently a memorial tablet has been placed in the

Beside the enthusiasm which he brought to his special work, he found an added pleasure at Cornell in the fact that the region in which the new university was situated contained another chapter in the book of glacial records he had so long been reading, and made also, as the following letter tells us, a natural sequence to his recent observations in the West.

TO M. DE LA RIVE.

ITHACA, *October* 26, 1868.

. . . I am passing some weeks here, and am studying the erratic phenomena, and especially the formation of the many small lakes which literally swarm in this region, and are connected in various ways with the glacial epoch. The journey which I have just completed has furnished me with a multitude of new facts concerning the glacial period, the long continuance of which, and its importance with reference to the physical history of the globe, become daily more clear to me. The origin and mode of formation of the vast system of our American rivers have especially occupied me, and I think I have found the solution of

Chapel at Cornell University by the trustees, recording their gratitude for the share he took in the initiation of the institution.

the problem which they present. This system reproduces the lines followed by the water over the surface of the ground moraines, which covered the whole continent, when the great sheet of ice which modeled the drift broke up and melted away. This conclusion will, no doubt, be as slow of acceptance as was the theory of the ancient extension of glaciers. But that does not trouble me. For my own part I am confident of its truth, and after having seen the idea of a glacial epoch finally adopted by all except those who are interested in opposing it on account of certain old and artificial theories, I can wait a little till the changes which succeeded that epoch are also understood. I have obtained direct proof that the prairies of the West rest upon polished rock. It has happened in the course of recent building on the prairie, that the native rock has been laid bare here and there, and this rock is as distinctly furrowed by the action of the glacier and by its engraving process, as the Handeck, or the slopes of the Jura. I have seen magnificent slabs in Nebraska in the basin of the river Platte. Do not the physicists begin to think of explaining to us the probable cause of changes so remarkable and so well estab-

lished? We can no longer evade the question by supposing these phenomena to be due to the action of great currents. We have to do first with sheets of ice, five or six thousand feet in thickness (an estimate which can be tested by indirect measurements in the Northern States), covering the whole continent, and then with the great currents which ensued upon the breaking up of that mass of ice. He who does not distinguish between these two series of facts, and perceive their connection, does not understand the geology of the Quaternary epoch. . . .

Of about this date is the following pleasant letter from Longfellow to Agassiz. Although it has no special bearing upon what precedes, it is inserted here, because their near neighborhood and constant personal intercourse, both at Cambridge and Nahant, made letters rare between them. Friends who see each other so often are infrequent correspondents.

ROME, *December* 31, 1868.

MY DEAR AGASSIZ, — I fully intended to write you from Switzerland, that my letter might come to you like a waft of cool air from a glacier in the heat of summer. But

alas! I did not find cool air enough for myself, much less to send across the sea. Switzerland was as hot as Cambridge, and all life was taken out of me; and the letter remained in the inkstand. I draw it forth as follows.

One of the things I most wished to say, and which I say first, is the delight with which I found your memory so beloved in England. At Cambridge, Professor Sedgwick said, "Give my love to Agassiz. Give him the blessing of an old man." In London, Sir Roderick Murchison said, "I have known a great many men that I liked; but I *love* Agassiz." In the Isle of Wight, Darwin said, "What a set of men you have in Cambridge! Both our universities put together cannot furnish the like. Why, there is Agassiz, — he counts for three."

One of my pleasantest days in Switzerland was that passed at Yverdon. In the morning I drove out to see the Gasparins. In their abundant hospitality they insisted upon my staying to dinner, and proposed a drive up the valley of the Orbe. I could not resist; so up the lovely valley we drove, and passed the old chateau of the Reine Berthe, one of my favorite heroines, but, what was far more to me, passed the little town of Orbe. There it

stands, with its old church tower and the trees on the terrace, just as when you played under them as a boy. It was very, very pleasant to behold. . . . Thanks for your letter from the far West. I see by the papers that you have been lecturing at the Cornell University.

With kindest greetings and remembrances, always affectionately yours,

H. W. L.

CHAPTER XXII.

1868–1871 : ÆT. 61–64.

New Subscription to Museum. — Additional Buildings. — Arrangement of New Collections. — Dredging Expedition on Board the Bibb. — Address at the Humboldt Centennial. — Attack on the Brain. — Suspension of Work. — Working Force at the Museum. — New Accessions. — Letter from Professor Sedgwick. — Letter from Professor Deshayes. — Restored Health. — Hassler Voyage proposed. — Acceptance. — Scientific Preparation for the Voyage.

Agassiz returned to Cambridge to find the Museum on an improved footing financially. The Legislature had given seventy-five thousand dollars for an addition to the building, and private subscriptions had doubled this sum, in order to provide for the preservation and arrangement of the new collections. In acknowledging this gift of the Legislature in his Museum Report for 1868 Agassiz says : —

"While I rejoice in the prospect of this new building, as affording the means for a complete exhibition of the specimens now stored in our cellars and attics and encumbering every room of the present edifice, I yet

can hardly look forward to the time when we shall be in possession of it without shrinking from the grandeur of our undertaking. The past history of our science rises before me with its lessons. Thinking men in every part of the world have been stimulated to grapple with the infinite variety of problems, connected with the countless animals scattered without apparent order throughout sea and land. They have been led to discover the affinities of various living beings. The past has yielded up its secrets, and has shown them that the animals now peopling the earth are but the successors of countless populations which have preceded them, and whose remains are buried in the crust of our globe. Further study has revealed relations between the animals of past time and those now living, and between the law of succession in the former and the laws of growth and distribution in the latter, so intimate and comprehensive that this labyrinth of organic life assumes the character of a connected history, which opens before us with greater clearness in proportion as our knowledge increases. But when the museums of the Old World were founded, these relations were not even suspected. The collections of natural history, gathered at im-

mense expense in the great centres of human civilization, were accumulated mainly as an evidence of man's knowledge and skill in exhibiting to the best advantage, not only the animals, but the products and curiosities of all sorts from various parts of the world. While we admire and emulate the industry and perseverance of the men who collected these materials, and did in the best way the work it was possible to do in their time for science, we have no longer the right to build museums after this fashion. The originality and vigor of one generation become the subservience and indolence of the next, if we only repeat the work of our predecessors. They prepared the ground for us by accumulating the materials for extensive comparison and research. They presented the problem ; we ought to be ready with the solution. If I mistake not, the great object of our museums should be to exhibit the whole animal kingdom as a manifestation of the Supreme Intellect. Scientific investigation in our day should be inspired by a purpose as animating to the general sympathy, as was the religious zeal which built the Cathedral of Cologne or the Basilica of St. Peter's. The time is passed when men expressed their deepest convictions by these

wonderful and beautiful religious edifices; but it is my hope to see, with the progress of intellectual culture, a structure arise among us which may be a temple of the revelations written in the material universe. If this be so, our buildings for such an object can never be too comprehensive, for they are to embrace the infinite work of Infinite Wisdom. They can never be too costly, so far as cost secures permanence and solidity, for they are to contain the most instructive documents of Omnipotence."

Agassiz gave the winter of 1869 to identifying, classifying, and distributing the new collections. A few weeks in the spring were, however, passed with his friend Count de Pourtalès in a dredging expedition on board the Coast Survey Steamer Bibb, off the coast of Cuba, on the Bahama Banks, and among the reefs of Florida. This dredging excursion, though it covered a wider ground than any previous one, was the third deep-sea exploration undertaken by M. de Pourtalès under the auspices of the Coast Survey. His investigations may truly be said to have exercised a powerful influence upon this line of research, and to have led the way to the more extended work of the same kind carried on

by the Coast Survey in later years. He had long wished to show his old friend and teacher some of the rich dredging grounds he had discovered between Florida and the West Indies, and they thoroughly enjoyed this short period of work together. Every day and hour brought some new interest, and excess of material seemed the only difficulty.

This was Agassiz's last cruise in the Bibb, on whose hospitable deck he had been a welcome guest from the first year of his arrival in this country. The results of this expedition, as connected with the present conformation of the continent and its probable geological history in the past, were given as follows in the Museum Bulletin of the same year.

REPORT UPON DEEP SEA DREDGINGS.[1]

BY LOUIS AGASSIZ.

From what I have seen of the deep-sea bottom, I am already led to infer that among the rocks forming the bulk of the stratified crust of our globe, from the oldest to the youngest formation, there are probably none which have been formed in very deep waters. If this be so, we shall have to admit that the areas now respectively occupied by our continents, as

[1] *Bull. Mus. Comp. Zoöl.*, I. No. 13, 1869, pp. 368, 369.

circumscribed by the two hundred fathom curve or thereabout, and the oceans at greater depth, have from the beginning retained their relative outline and position; the continents having at all times been areas of gradual upheaval with comparatively slight oscillations of rise and subsidence, and the oceans at all times areas of gradual depression with equally slight oscillations. Now that the geological constitution of our continent is satisfactorily known over the greatest part of its extent, it seems to me to afford the strongest evidence that this has been the case; while there is no support whatever for the assumption that any part of it has sunk again to any very great depth after its rise above the surface of the ocean. The fact that upon the American continent, east of the Rocky Mountains, the geological formations crop out in their regular succession, from the oldest azoic and primordial deposits to the cretaceous formation, without the slightest indication of a great subsequent subsidence, seems to me the most complete and direct demonstration of my proposition. Of the western part of the continent I am not prepared to speak with the same confidence. Moreover, the position of the cretaceous and tertiary formations along

the low grounds east of the Alleghany range is another indication of the permanence of the ocean trough, on the margin of which these more recent beds have been formed. I am well aware that in a comparatively recent period, portions of Canada and the United States, which now stand six or seven hundred feet above the level of the sea, have been under water; but this has not changed the configuration of the continent, if we admit that the latter is in reality circumscribed by the two hundred fathom curve of depth.

The summer was passed in his beloved laboratory at Nahant (as it proved, the last he ever spent there), where he was still continuing the preparation of his work on sharks and skates. At the close of the summer, he interrupted this occupation for one to which he brought not only the reverence of a disciple, but a life-long debt of personal gratitude and affection. He had been entreated to deliver the address at the Humboldt Centennial Celebration (September 15, 1869), organized under the auspices of the Boston Society of Natural History. He had accepted the invitation with many misgivings, for to literary work as such he was unaccustomed, and in

the field of the biographer he felt himself a novice. His preparation for the task was conscientious and laborious. For weeks he shut himself up in a room of the Public Library in Boston and reviewed all the works of the great master, living, as it were, in his presence. The result was a very concise and yet full memoir, a strong and vigorous sketch of Humboldt's researches, and of their influence not only upon higher education at the present day, but on our most elementary instruction, until the very "school-boy is familiar with his methods, yet does not know that Humboldt is his teacher." Agassiz's picture of this generous intellect, fertilizing whatever it touched, was made the more life-like by the side lights which his affection for Humboldt and his personal intercourse with him in the past enabled him to throw upon it. Emerson, who was present, said of this address, "that Agassiz had never delivered a discourse more wise, more happy, or of more varied power." George William Curtis writes of it: "Your discourse seems to me the very ideal of such an address, — so broad, so simple, so comprehensive, so glowing, so profoundly appreciative, telling the story of Humboldt's life and work as I am sure no other living man can tell it."

In memory of this occasion the "Humboldt Scholarship" was founded at the Museum of Comparative Zoölogy.

It is hardly worth while to consider now whether this effort, added to the pressing work of the year, hastened the attack which occurred soon after, with its warning to Agassiz that his overtasked brain could bear no farther strain. The first seizure, of short duration, but affecting speech and motion while it lasted, was followed by others which became less and less acute until they finally disappeared. For months, however, he was shut up in his room, absolutely withdrawn from every intellectual effort, and forbidden by his physicians even to think. The fight with his own brain was his greatest difficulty, and perhaps he showed as much power in compelling his active intellect to stultify itself in absolute inactivity for the time, as he had ever shown in giving it free rein. Yet he could not always banish the Museum, the passionate dream of his American life. One day, after dictating some necessary directions concerning it, he exclaimed, with a sort of despairing cry, "Oh, my Museum! my Museum! always uppermost, by day and by night, in health and in sickness, always — *always!*"

He was destined, however, to a few more years of activity, the reward, perhaps, of his patient and persistent struggle for recovery. After a winter of absolute seclusion, passed in his sick chamber, he was allowed by his physician, in the spring of 1870, to seek change at the quiet village of Deerfield on the Connecticut River. Nature proved the best physician. Unable when he arrived to take more than a few steps without vertigo, he could, before many weeks were over, walk several miles a day. Keen as an Egyptologist for the hieroglyphics of his science, he was soon deciphering the local inscriptions of the glacial period, tracking the course of the ice on slab and dike and river-bed, — on every natural surface. The old music sang again in his ear and wooed him back to life.

In the mean time, his assistants and students were doing all in their power to keep the work of the Museum at high-water mark. The publications, the classification and arrangement of the more recent collections, the distribution of such portions as were intended for the public, the system of exchanges, went on uninterruptedly. The working force at the Museum was, indeed, now very strong. In great degree it was, so to speak, home-bred.

Agassiz had gradually gathered about him, chiefly from among his more special students, a staff of assistants who were familiar with his plans and shared his enthusiasm. To these young friends he was warmly attached. It would be impossible to name them all, but the knot of younger men who were for years his daily associates in scientific work, whose sympathy and coöperation he so much valued, and who are now in their turn growing old in the service of science, will read the roll-call between the lines, and know that none are forgotten here. Years before his own death, he had the pleasure of seeing several of them called to important scientific positions, and it was a cogent evidence to him of the educational efficiency of the Museum, that it had supplied to the country so many trained investigators and teachers. Through them he himself teaches still. There was a prophecy in Lowell's memorial lines: —

> "He was a Teacher: why be grieved for him
> Whose living word still stimulates the air?
> In endless file shall loving scholars come,
> The glow of his transmitted touch to share."

Beside these, there were several older, experienced naturalists, who were permanently or transiently engaged at the Museum. Some

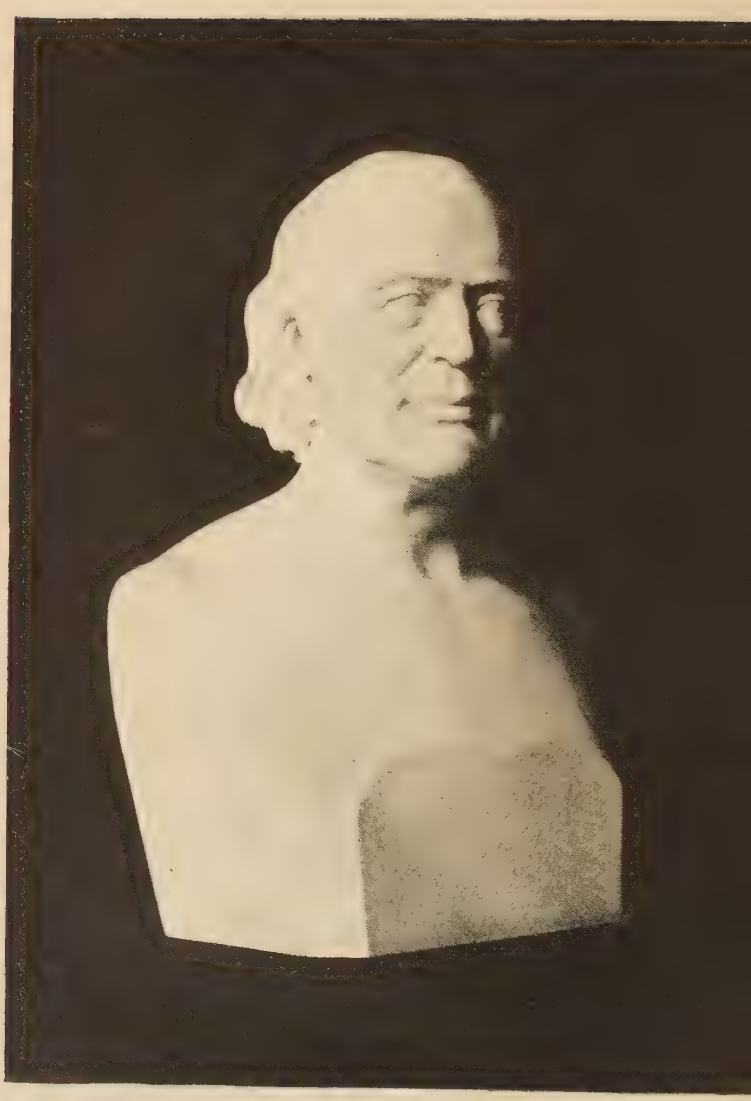
were heads of departments, while others lent assistance occasionally in special work. Again the list is too long for enumeration, but as the veteran among the older men Mr. J. G. Anthony should be remembered. Already a conchologist of forty years' standing when he came to the Museum in 1863, he devoted himself to the institution until the day of his death, twenty years later. Among those who came to give occasional help were Mr. Lesquereux, the head of paleontological botany in this country; M. Jules Marcou, the geologist; and M. de Pourtalès, under whose care the collection of corals was constantly improved and enlarged. The last named became at last wholly attached to the Museum, sharing its administration with Alexander Agassiz after his father's death.

To this band of workers some accessions had recently been made. More than two years before, Agassiz had been so fortunate as to secure the assistance of the entomologist, Dr. Hermann Hagen, from Königsberg, Prussia. He came at first only for a limited time, but he remained, and still remains, at the Museum, becoming more and more identified with the institution, beside filling a place as professor in Harvard University. His scientific

sympathy and support were of the greatest value to Agassiz during the rest of his life. A later new-comer, and a very important one at the Museum, was Dr. Franz Steindachner, of Vienna, who arrived in the spring of 1870 to put in final order the collection of Brazilian fishes, and passed two years in this country. Thus Agassiz's hands were doubly strengthened. Beside having the service of the salaried assistants and professors, the Museum received much gratuitous aid. Among the scientific volunteers were numbered for years François de Pourtalès, Theodore Lyman, James M. Barnard, and Alexander Agassiz, while the business affairs of the institution were undertaken by Thomas G. Cary, Agassiz's brother-in-law. The latter had long been of great service to the Museum as collector on the Pacific coast, where he had made this work his recreation in the leisure hours of a merchant's life.[1]

Broken as he was in health, it is amazing to see the amount of work done or directed by Agassiz during this convalescent summer of 1870. The letters written by him in this

[1] For the history of the Museum in later times reference is made to the regular reports and publications of the institution.



BUST OF AGASSIZ.

By Powers.

time concerning the Museum alone would fill a good-sized volume. Such a correspondence is unfit for reproduction here, but its minuteness shows that almost the position of every specimen, and the daily, hourly work of every individual in the Museum, were known to him. The details of administration form, however, but a small part of the material of this correspondence. The consideration and discussion of the future of the Museum with those most nearly concerned, fill many of the letters. They give evidence of a fostering and far-reaching care, which provided for the growth and progress of the Museum, long after his own share in it should have ceased.

In reviewing Agassiz's scientific life in the United States, its brilliant successes, and the genial generous support which it received in this country, it is natural to give prominence to the brighter side. And yet it must not be forgotten that like all men whose ideals outrun the means of execution, he had moments of intense depression and discouragement. Some of his letters, written at this time to friends who controlled the financial policy of the Museum, are almost like a plea for life. While the trustees urge safe investments and the expenditure of income alone, he believes that in

proportion to the growth and expansion of the Museum will be its power of self-maintenance and its claim on the community at large. In short, expenditure seemed to him the best investment, insuring a fair return, on the principle that the efficiency and usefulness of an institution will always be the measure of the support extended to it. The two or three following letters, in answer to letters from Agassiz which cannot be found, show how earnestly, in spite of physical depression, he strove to keep the Museum in relation with foreign institutions, to strengthen the former, and coöperate as far as possible with the latter.

FROM PROFESSOR VON SIEBOLD.

MUNICH, 1869.

. . . Most gladly shall I meet your wishes both with regard to the fresh-water fishes of Central Europe and to your desire for the means of direct comparison between the fishes brought by Spix from Brazil and described by you, and those you have recently yourself collected in the Amazons. The former, with one exception, are still in existence and remain undisturbed, for since your day no one has cared to work at the fishes or reptiles. Schubert took no interest in the zoölogical cabinet

intrusted to him; and Wagner, who later relieved him of its management, cared chiefly for the mammals. I have now, however, given particular attention to the preservation of everything determined by you, so far as it could be found, and am truly glad that this material is again to be called into the service of science. Of course I had to ask permission of the "General Conservatorium of Scientific Collections" before sending this property of the state on so long a journey. At my urgent request this permission was very cordially granted by Herr von Liebig, especially as our collection is likely to be increased by the new forms you offer us.

As to the fresh-water fishes I must beg for a little time. At the fish market, in April or May, I can find those Cyprinoids, the males of which bear at the spawning season that characteristic eruption of the skin, which has so often and so incorrectly led to the making of new species. . . .

From your son Alexander I receive one beautiful work after another. Give him my best thanks for these admirable gifts, which I enter with sincere pleasure in my catalogue of books. You are indeed happy to have such a co-worker at your side. At the next oppor-

tunity I shall write my thanks to him personally.

How is Dr. Hermann Hagen pleased with his new position? I think the presence of this superior entomologist will exert a powerful and important influence upon the development of entomology in North America. . . .

FROM PROFESSOR G. P. DESHAYES.

MUSEUM OF NATURAL HISTORY,
PARIS, *February* 4, 1870.

Your letter was truly an event, my dear friend, not only for me but for our Museum. . . . How happy you are, and how enviable has been your scientific career, since you have had your home in free America! The founder of a magnificent institution, to which your glorious name will forever remain attached, you have the means of carrying out whatever undertaking commends itself to you as useful. Men and things, following the current that sets toward you, are drawn to your side. You desire, and you see your desires carried out. You are the sovereign leader of the scientific movement around you, of which you yourself have been the first promoter.

What would our old Museum not have gained in having at its head a man like you!

We should not now be lying stagnant in a space so insufficient that our buildings, by the mere force of circumstances, are transformed into store-houses, where objects of study are heaped together, and can be of no use to any one. . . . You can fancy how much I envy your organization. It depressed me to read your letter, with its brilliant proposals of exchange, remembering how powerless we are to meet even a small number of them. Your project is certainly an admirable one; to find the scientific nomenclature where it is best established, and by the help of good specimens transport it to your own doors. Nothing could be better, and I would gladly assist in it. But to succeed in this excellent enterprise one must have good duplicate specimens; not having them, one must have money. As a conclusion to your letter, the question of money was brought before my assembled colleagues, but the answer was vague and uncertain. I must, then, find resources in some other way, and this is what I propose to do. . . . [Here follow some plans for exchange.] Beside this, I will busy myself in getting together authentic collections from our French seas, both Oceanic and Mediterranean, and even from other points in the European seas.

Meantime, you shall have your share henceforth in whatever comes to me. . . . I learn from your son that your health is seriously attacked. I was grieved to hear it. Take care of yourself, my dear friend. You are still needed in this world; you have a great work to accomplish, the end and aim of which you alone are able to reach. You must, therefore, still stand in the breach for some years to come.

Your letter, which shows me the countless riches you have to offer at the Museum, puts me in the frame of mind of the child who was offered his choice in a toy-shop. "I choose everything," he said. I could reply in the same way. I choose all you offer me. Still, one must be reasonable, and I will therefore name, as the thing I chiefly desire, the remarkable fauna dredged from the Gulf Stream. Let me add, however, in order to give you entire freedom, that whatever you may send to the Museum will be received with sincere and ardent gratitude.

And so, farewell, my dear friend, with a warm shake of the hand and the most cordial regard. DESHAYES.

The next is in answer to a letter from

Agassiz to the veteran naturalist, Professor Sedgwick, concerning casts of well-known fossil specimens in Cambridge, England. Though the casts were unattainable, the affectionate reply gave Agassiz keen pleasure.

FROM PROFESSOR ADAM SEDGWICK.

THE CLOSE, NORWICH, *August* 9, 1871.

MY VERY DEAR AND HONORED FRIEND, — . . . I of course showed your letter to my friend Seeley, and after some consultation with men of practical knowledge, it was considered almost impossible to obtain such casts of the reptilian bones as you mention. The specimens of the bones are generally so rugged and broken, that the artists would find it extremely difficult to make casts from them without the risk of damaging them, and the authorities of the university, who are the proprietors of the whole collection in my Museum, would be unwilling to encounter that risk. Mr. Seeley, however, fully intends to send you a gutta-percha cast of the cerebral cavity of one of our important specimens described in "Seeley's Catalogue," but he is full of engagements and may not hitherto have realized his intentions. As for myself, at present I can do nothing except hobble daily on my stick from my house

to the Cathedral, for I am afflicted by a painful lameness in my left knee. The load of years begins to press upon me (I am now toiling through my 87th year), and my sight is both dim and irritable, so that, as a matter of necessity, I am generally compelled to employ an amanuensis. That part is now filled by a niece who is to me in the place of a dear daughter.

I need not tell you that the meetings of the British Association are still continued, and the last session (this year at Edinburgh) only ended yesterday. Let me correct a mistake. I met you first at Edinburgh in 1834, the year I became Canon, and again at Dublin in 1835. . . . It is a great pleasure to me, my dear friend, to see again by the vision of memory that fine youthful person, that benevolent face, and to hear again, as it were, the cheerful ring of the sweet and powerful voice by which you made the old Scotchmen start and stare, while you were bringing to life again the fishes of their old red sandstone. I must be content with the visions of memory and the feelings they again kindle in my heart, for it will never be my happiness to see your face again in this world. But let me, as a Christian man, hope that we may meet hereafter in

heaven, and see such visions of God's glory in the moral and material universe, as shall reduce to a mere germ everything which has been elaborated by the skill of man, or revealed to God's creatures. I send you an old man's blessing, and remain,

Your affectionate friend,

ADAM SEDGWICK.

In November, 1870, Agassiz was able to return to Cambridge and the Museum, and even to resume his lectures, which were as vigorous and fresh as ever. So entirely did he seem to have recovered, that in the course of the winter the following proposition was made to him by his friend, Professor Benjamin Peirce, then Superintendent of the Coast Survey.

FROM PROFESSOR PEIRCE.

COAST SURVEY OFFICE, WASHINGTON,
February 18, 1871.

. . . I met Sumner in the Senate the day before yesterday, and he expressed immense delight at a letter he had received from Brown-Séquard, telling him that you were altogether free from disease. . . . Now, my dear friend, I have a very serious proposition for you. I am going to send a new iron sur-

veying steamer round to California in the course of the summer. She will probably start at the end of June. Would you go in her, and do deep-sea dredging all the way round? If so, what companions will you take? If not, who shall go? . . .

FROM AGASSIZ TO PROFESSOR PEIRCE.

CAMBRIDGE, *February* 20, 1871.

. . . I am everjoyed at the prospect your letter opens before me. Of course I will go, unless Brown-Séquard orders me positively to stay on terra firma. But even then, I should like to have a hand in arranging the party, as I feel there never was, and is not likely soon again to be, such an opportunity for promoting the cause of science generally, and that of natural history in particular. I would like Pourtalès and Alex. to be of the party, and both would gladly join if they can. Both are as much interested about it as I am, and I have no doubt between us we may organize a working team, strong enough to do something creditable. It seems to me that the best plan to pursue in the survey would be to select carefully a few points (as many as time would allow) on shore, from which to work at right angles with the coast, to as great a distance as

the results would justify, and then move on to some other head-land. If this plan be adopted, it would be desirable to have one additional observer to make collections on shore, to connect with the result of the dredgings. This would be the more important as, with the exception of Brazil, hardly anything is known of the shore faunæ upon the greater part of the South American coast. For shore observations, I should like a man of the calibre of Dr. Steindachner, who has spent a year on the coast of Senegal, and would thus bring a knowledge of the opposite side of the Atlantic as a starting basis of comparison. . . .

After consultation with his physicians, it was decided that Agassiz might safely undertake the voyage in the Hassler, that it might indeed be of benefit to his health. His party of naturalists, as finally made up, consisted of Agassiz himself, Count de Pourtalès, Dr. Franz Steindachner, and Mr. Blake, a young student from the Museum, who accompanied Agassiz as assistant and draughtsman. Dr. Thomas Hill, ex-president of Harvard University, was also on the expedition, and though engaged in special investigations of his own, he joined in all the work with genial interest.

The vessel was commanded by Captain (now Commodore) Philip C. Johnson, whose courtesy and kindness made the Hassler a floating home to the guests on board. So earnest and active was the sympathy felt by him and his officers in the scientific interests of the expedition, that they might be counted as a valuable additional volunteer corps. Among them should be counted Dr. William White, of Philadelphia, who accompanied the expedition in a partly professional, partly scientific capacity.

The hopes Agassiz had formed of this expedition, as high as those of any young explorer, were only partially fulfilled. His enthusiasm, though it had the ardor of youth, had none of its vagueness. In a letter to Mr. Peirce, published in the Museum Bulletin at this time, there is this passage: "If this world of ours is the work of intelligence and not merely the product of force and matter, the human mind, as a part of the whole, should so chime with it, that from what is known it may reach the unknown. If this be so, the knowledge gathered should, within the limits of error which its imperfection renders unavoidable, enable us to foretell what we are likely to find in the deepest abysses of the sea." He looked, in short, for the solution of special

problems directly connected with all his previous work. He believed the deeper sea would show forms of life akin to animals of earlier geological times, throwing new light on the relation between the fossil and the living world. In the letter above quoted, he even named the species he expected to find most prevalent in those greater depths: as, for instance, representatives of the older forms of Ganoids and Selachians; Cephalopods, resembling the more ancient chambered shells; Gasteropods, recalling the tertiary and cretaceous types; and Acephala, resembling those of the jurassic and cretaceous formations. He expected to find Crustaceans also, more nearly approaching the ancient Trilobites than those now living on the surface of the globe; and among Radiates he looked for the older forms of sea-urchins, star-fishes, and corals. Although the collections brought together on this cruise were rich and interesting, they gave but imperfect answers to these comprehensive questions. Owing to defects in the dredging apparatus, the hauls from the greatest depths were lost.

With reference to the glacial period he anticipated still more positive results. In the same letter the following passage occurs:

"There is, however, still one kind of evidence wanting, to remove all doubt that the greater extension of glaciers in former ages was connected with cosmic changes in the physical condition of our globe. Namely, all the phenomena relating to the glacial period must be found in the southern hemisphere, accompanied by the same characteristic features as in the north, but with this essential difference, — that everything must be reversed. The trend of the glacial abrasions must be from the south northward, the lee-side of abraded rocks must be on the north side of the hills and mountain ranges, and the boulders must have traveled from the south to their present position. Whether this be so or not, has not yet been ascertained by direct observation. I expect to find it so throughout the temperate and cold zones of the southern hemisphere, with the exception of the present glaciers of Terra del Fuego and Patagonia, which may have transported boulders in every direction. Even in Europe, geologists have not yet sufficiently discriminated between local glaciers, and the phenomena connected with their different degrees of successive retreat on the one hand; and, on the other, the facts indicating the action of an extensive sheet of ice moving

over the whole continent from north to south. Among the facts already known from the southern hemisphere are the so-called rivers of stone in the Falkland Islands, which attracted the attention of Darwin during his cruise with Captain Fitzroy, and which have remained an enigma to this day. I believe it will not be difficult to explain their origin in the light of the glacial theory, and I fancy they may turn out to be ground moraines similar to the 'horsebacks' in Maine.

"You may ask what this question of drift has to do with deep-sea dredging? The connection is closer than may at first appear. If drift is not of glacial origin, but is the product of marine currents, its formation at once becomes a matter for the Coast Survey to investigate. But I believe it will be found in the end, that so far from being accumulated by the sea, the drift of the Patagonian lowlands has been worn away by the sea to its present outline, like the northern shores of South America and Brazil." . . .

This is not the place for a detailed account of the voyage of the Hassler, but enough may be told to show something of Agassiz's own share in it. A journal of scientific and personal experience, kept by Mrs. Agassiz under

his direction, was nearly ready for publication at the time of his death. The two next chapters, devoted to the cruise of the Hassler, are taken from that manuscript. A portion of it appeared many years ago in the pages of the "Atlantic Monthly."

CHAPTER XXIII.

1871–1872 : ÆT. 64–65.

Sailing of the Hassler. — Sargassum Fields. — Dredging at Barbadoes. — From the West Indies to Rio de Janeiro. — Monte Video. — Quarantine. — Glacial Traces in the Bay of Monte Video. — The Gulf of Mathias. — Dredging off Gulf of St. George. — Dredging off Cape Virgens. — Possession Bay. — Salt Pool. — Moraine. — Sandy Point. — Cruise through the Straits. — Scenery. — Wind Storm. — Borja Bay. — Glacier Bay. — Visit to the Glacier. — Chorocua Bay.

THE vessel was to have started in August, but, owing to various delays in her completion, she was not ready for sea until the late autumn. She finally sailed on December 4, 1871, on a gray afternoon, which ushered in the first snow-storm of the New England winter. Bound for warmer skies, she was, however, soon in the waters of the Gulf Stream, where the work of collecting began in the fields of Sargassum, those drifting, wide-spread expanses of loose sea-weed carrying a countless population, lilliputian in size, to be sure, but very various in character. Agassiz was no

less interested than other naturalists have been in the old question so long asked and still unanswered, about the Sargassum. "Where is its home, and what its origin? Does it float, a rootless wanderer on the deep, or has it broken away from some submarine attachment?" He had passed through the same region before, in going to Brazil, but then he was on a large ocean steamer, while from the little Hassler, of 360 tons, one could almost fish by hand from the Sargassum fields. Some of the chief results are given in the following letter.

TO PROFESSOR PEIRCE.

ST. THOMAS, *December* 15, 1871.

. . . As soon as we reached the Gulf Stream we began work. Indeed, Pourtalès had organized a party to study the temperatures as soon as we passed Gay Head, and will himself report to you his results. My own attention was entirely turned to the Gulf weed and its inhabitants, of which we made extensive collections. Our observations on the floating weed itself favor the view of those who believe it to be torn from rocks, on which Sargassum naturally grows. I made a simple experiment which seems to me conclusive. Any branch of the sea-weed which is deprived

of its *floats* sinks at once to the bottom of the water, and these floats are not likely to be the first parts developed from the spores. Moreover, after examining large quantities of the weed, I have not seen a single branch, however small, which did not show marks of having been torn from a solid attachment.

You may hardly feel an interest in my zoological observations, but I am sure you will be glad to learn that we had the best opportunity of carefully examining most of the animals known to inhabit the Gulf weed, and some also which I did not know to occur among them. The most interesting discovery of our voyage thus far, however, is that of a nest built by a fish, and floating on the broad ocean with its living freight. On the 13th, Mr. Mansfield, one of our officers, brought me a ball of Gulf weed which he had just picked up, and which excited my curiosity to the utmost. It was a round mass of Sargassum about the size of two fists. The bulk of the ball was made up of closely packed branches and leaves, held together by fine threads, running through them in every direction, while other branches hung more loosely from the margin. Placed in a large bowl of water it became apparent that the loose branches

served to keep the central mass floating, cradle-like, between them. The elastic threads, which held the ball of Gulf weed together, were beaded at intervals, sometimes two or three beads close together, or a bunch of them hanging from the same cluster of threads, or occasionally scattered at a greater distance from each other. Nowhere was there much regularity in the distribution of the beads. They were scattered pretty uniformly throughout the whole ball of sea-weed, and were themselves about the size of an ordinary pin's head. Evidently we had before us a nest of the most curious kind, full of eggs. What animal could have built this singular nest? It did not take long to ascertain the class to which it belonged. A common pocket lens revealed at once two large eyes on the side of the head, and a tail bent over the back of the body, as in the embryo of ordinary fishes shortly before the period of hatching. The many empty egg cases in the nest gave promise of an early opportunity of seeing some embryos, freeing themselves from their envelope. Meanwhile a number of these eggs containing live embryos were cut out of the nest and placed in separate glass jars, in order to multiply the chances of preserving them;

while the nest as a whole was secured in alcohol, as a memorial of our discovery.

The next day I found two embryos in my glass jars; they moved occasionally in jerks, and then rested a long time motionless on the bottom of the jar. On the third day I had over a dozen of these young fishes, the oldest beginning to be more active. I need not relate in detail the evidence I soon obtained that these embryos were actually fishes. . . . But what kind of fish was it? At about the time of hatching, the fins differ too much from those of the adult, and the general form has too few peculiarities, to give any clew to this problem. I could only suppose it would prove to be one of the pelagic species of the Atlantic. In former years I had made a careful study of the pigment cells of the skin in a variety of young fishes, and I now resorted to this method to identify my embryos. Happily we had on board several pelagic fishes alive. The very first comparison I made gave the desired result. The pigment cell of a young Chironectes pictus proved identical with those of our little embryos. It thus stands, as a well authenticated fact, that the common pelagic Chironectes of the Atlantic, named Ch. pictus by Cuvier, builds a nest for

its eggs in which the progeny is wrapped up with the materials of which the nest itself is composed; and as these materials consist of the living Gulf weed, the fish cradle, rocking upon the deep ocean, is carried along as in an arbor, which affords protection and afterwards food also, to its living freight. This marvelous story acquires additional interest, when we consider the characteristic peculiarities of the genus Chironectes. As its name indicates, it has fin-like hands; that is to say, the pectoral fins are supported by a kind of long wrist-like appendage, and the rays of the ventrals are not unlike rude fingers. With these limbs these fishes have long been known to attach themselves to sea-weeds, and rather to walk than to swim in their natural element. But now that we know their mode of reproduction, it may fairly be asked if the most important use of their peculiarly constructed fins is not the building of their nest? . . . There thus remains one closing chapter to the story. May some naturalist, becalmed among the Gulf weed, have the good fortune to witness the process by which the nest is built. . . .

This whole investigation was of the greatest interest to Agassiz, and, coming so early in

the voyage, seemed a pleasant promise of its farther opportunities. The whole ship's company soon shared his enthusiasm, and the very sailors gathered about him in the intervals of their work, or hung on the outskirts of the scientific circle. A pause of a few days was made at one or two of the West Indian islands, at St. Thomas and Barbadoes. At the latter, the first cast of the large dredge was made on a ledge of shoals in a depth of eighty fathoms, and, among countless other things, a number of stemmed crinoids and comatulæ were brought up. An ardent student of the early fossil echinoderms, it was a great pleasure to Agassiz to gather their fresh and living representatives. It was like turning a leaf of the past and finding the subtle thread which connects it with the present.

TO PROFESSOR PEIRCE.

PERNAMBUCO, *January* 16, 1872.

MY DEAR PEIRCE, — I should have written to you from Barbadoes, but the day before we left the island was favorable for dredging, and our success in that line was so unexpectedly great, that I could not get away from the specimens, and made the most of them for study while I had the chance. We made only four

hauls, in between seventy-five and one hundred and twenty fathoms. But what hauls! Enough to occupy half a dozen competent zoologists for a whole year, if the specimens could be kept fresh for that length of time. The first haul brought up a Chemidium-like sponge; the next gave us a crinoid, very much like the Rhizocrinus lofotensis, but probably different; the third, a living Pleurotomaria; the fourth, a new genus of Spatangoids, etc., etc., not to speak of the small fry. We had the crinoid alive for ten or twelve hours. When contracted, the pinnules are pressed against the arms, and the arms themselves shut against one another, so that the whole looks like a swash made up of a few long, coarse twines. When the animal opens, the arms at first separate without bending outside, so that the whole looks like an inverted pentapod; but gradually the tips of the arms bend outward as the arms diverge more and more, and when fully expanded the crown has the appearance of a lily of the L. martagon type, in which each petal is curved upon itself, the pinnules of the arms spreading laterally more and more, as the crown is more fully open. I have not been able to detect any motion in the stem traceable to contrac-

tion, though there is no stiffness in its bearing. When disturbed, the pinnules of the arms first contract, the arms straighten themselves out, and the whole gradually and slowly closes up. It was a very impressive sight for me to watch the movements of the creature, for it not only told of its own ways, but at the same time afforded a glimpse into the countless ages of the past, when these crinoids, so rare and so rarely seen nowadays, formed a prominent feature of the animal kingdom. I could see, without great effort of the imagination, the shoal of Lockport teeming with the many genera of crinoids which the geologists of New York have rescued from that prolific Silurian deposit, or recall the formations of my native country, in the hill-sides of which also, among fossils indicating shoal water deposits, other crinoids abound, resembling still more closely those we find in these waters. The close affinities of Rhizocrinus with Apiocrinoids are further exemplified by the fact that when the animal dies, it casts off its arms, like Apiocrinus, the head of which is generally found without arms. And now the question may be asked, what is the meaning of the occurrence of these animals in deep waters at the present day, when, in former

ages, similar types inhabited shallow seas? Of the fact there can be no doubt, for it is not difficult to adduce satisfactory evidence of the shoal-like character of the Silurian deposits of the State of New York; their horizontal position, combined with the gradual recession of the higher beds in a southerly direction, leaves no doubt upon this point; and in the case of the jurassic formation alluded to above, the combination of the crinoids with fossils common upon coral reefs, and their presence in atolls of that period, are satisfactory proofs of my assertion. What does it mean, then, when we find the Pentacrinus and Rhizocrinus of the West Indies in deep water only? It seems to me that there is but one explanation of the fact, namely, that in the progress of the earth's growth, we must look for such a displacement of the conditions favorable to the maintenance of certain lower types, as may recall most fully the adaptations of former ages. It was in this sense I alluded, in my first letter to you, to the probability of our finding in deeper water representatives of earlier geological types; and if my explanation is correct, my anticipation is also fully sustained. But do the deeper waters of the present constitution of our globe really ap-

proximate the conditions for the development of animal life, which existed in the shallower seas of past geological ages? I think they do, or at least I believe they approach it as nearly as anything can in the present order of things upon earth; for the depths of the ocean alone can place animals under a pressure corresponding to that caused by the heavy atmosphere of earlier periods. But, of course, such high pressure as animals meet in great depths cannot be a favorable condition for the development of life; hence the predominance of lower forms in the deep sea. The rapid diminution of light with the increasing depth, and the small amount of free oxygen in these waters under greater and greater pressure, not to speak of other limitations arising from the greater uniformity of the conditions of existence, the reduced amount and less variety of nutritive substances, etc., etc., are so many causes acting in the same direction and with similar results. For all these reasons, I have always expected to find that the animals living in great depths would prove to be of a standing, in the scale of structural complications, inferior to those found in shoal waters or near shore; and the correlation elsewhere pointed out between the standing of animals

and their order of succession in geological times (see "Essay on Classification") justifies another form of expression of these facts, namely, that in deeper waters we should expect to find representatives of earlier geological periods. There is in all this nothing which warrants the conclusion that any of the animals now living are lineal descendants of those of earlier ages; nor does their similarity to those of earlier periods justify the statement that the cretaceous formation is still extant. It would be just as true to nature to say that the tertiaries are continued in the tropics, on account of the similarity of the miocene mammalia to those of the torrid zone.

We have another case in the Pleurotomaria. It is not long since it has been made known that the genus Pleurotomaria is not altogether extinct, a single specimen having been discovered about ten years ago in the West Indies. Even Pictet, in the second edition of his Paleontology, still considers Pleurotomaria as extinct, and as belonging to the fossiliferous formations which extend from the Silurian period to the Tertiary. Of the living species found at Marie Galante, nothing is known except the specific characteristics of the shell. We dredged it in one hundred and twenty

fathoms, on the west side of Barbadoes, alive, and kept it alive for twenty-four hours, during which time the animal expanded and showed its remarkable peculiarities. It is unquestionably the type of a distinct family, entirely different from the other Mollusks with which it has been hitherto associated. Mr. Blake has made fine colored drawings of it, which may be published at some future time. . . . The family of the Pleurotomariæ numbers between four and five hundred fossil species, beginning in the Silurian deposits, but especially numerous in the carboniferous and jurassic formations.

The sponges afford another interesting case. When the first number of the great work of Goldfuss, on the fossils of Germany, made its appearance, about half a century ago, the most novel types it made known were several genera of sponges from the jurassic and cretaceous beds, described under the names of Siphonia, Chemidium, and Scyphia. Nothing of the kind has been known among the living to this day; and yet, the first haul of the dredge near Barbadoes gave us a Chemidium, or, at least, a sponge so much like the fossil Chemidium, that it must remain for future comparisons to determine whether there are

any generic differences between our living sponge and the fossil. The next day brought us a genuine Siphonia, another genus thus far only known from the jurassic beds; and it is worth recording, that I noticed in the collection of Governor Rawson another sponge, — brought to him by a fisherman who had caught it on his line, on the coast of Barbadoes, — which belongs to the genus Scyphia. Thus the three characteristic genera of sponges from the secondary formation, till now supposed to be extinct, are all three represented in the deep waters of the West Indies. . . .

Another family of organized beings offers a similar testimony to that already alluded to. If there is a type of Echinoderms characteristic of a geological period, it is the genus Micraster of the cretaceous formation, in its original circumscription. No species of this genus is known to have existed during the Tertiary era, and no living species has as yet been made known. You may therefore imagine my surprise when the dredge first yielded three specimens of a small species of that particular group of the genus, which is most extensively represented in the upper cretaceous beds.

Other examples of less importance might be

enumerated; suffice it now to add that my expectation of finding in deep waters animals already known, but thus far exceedingly rare in museums, is already in a measure realized. . . .

Little can be said of the voyage from the West Indies to Rio de Janeiro. It had the usual vicissitudes of weather, with here and there a flight (so it might justly be called) of flying-fish, a school of porpoises or dog-fish, or a sail in the distance, to break the monotony. At Rio de Janeiro it became evident that the plan of the voyage must be somewhat curtailed. This was made necessary partly by the delays in starting, — in consequence of which the season would be less favorable than had been anticipated along certain portions of the proposed route, — and partly by the defective machinery, which had already given some trouble to the Captain. The Falkland Islands, the Rio Negro, and the Santa Cruz rivers were therefore renounced; with what regret will be understood by those who know how hard it is to be forced to break up a scheme of work, which was originally connected in all its parts. The next pause was at Monte Video; but as there was a strict

quarantine, Agassiz was only allowed to land at the Mount, a hill on the western side of the bay, the geology of which he was anxious to examine. He found true erratics — loose pebbles, granite, gneiss, and granitic sandstone, having no resemblance to any native rock in the vicinity — scattered over the whole surface of the hill to its very summit. The hill itself had also the character of the "roches moutonnées" modeled by ice in the northern hemisphere. As these were the most northern erratics and glaciated surfaces reported in the southern hemisphere, the facts there were very interesting to him.

With dredgings off the Rio de la Plata, and along the coast between that and the Rio Negro, the vessel held on her way to the Gulf of Mathias, a deep, broad bay running some hundred miles inland, and situated a little south of the Rio Negro. Here some necessary repairs enforced a pause, of which Agassiz took advantage for dredging and for studying the geology of the cliffs along the north side of the bay. As seen from the vessel, they seemed to be stratified with extraordinary evenness and regularity to within a few feet of the top, the summit being crowned with loose sand. Farther on, they sank to sand

dunes piled into rounded banks and softly moulded ledges, like snow-drifts. Landing the next day at a bold bluff marked Cliff End on the charts, he found the lower stratum to consist of a solid mass of tertiary fossils, chiefly immense oysters, mingled, however, with sea-urchins. Superb specimens were secured, — large boulders crowded with colossal shells and perfectly preserved echini. From the top of the cliff, looking inland, only a level plain was seen, stretching as far as the eye could reach, broken by no undulations, and covered with low, scrubby growth. The seine was drawn on the beach, and yielded a good harvest for the fish collection. At evening the vessel anchored at the head of the bay, off the Port of San Antonio. The name would seem to imply some settlement; but a more lonely spot cannot be imagined. More than thirty years ago, Fitzroy had sailed up this bay, partially surveyed it, and marked this harbor on his chart. If any vessel has broken the loneliness of its waters since, no record of any such event has been kept. Of the presence of man, there was no sign. Yet the few days passed there were among the pleasantest of the voyage to Agassiz. The work of the dredge and seine was extremely successful, and the

rambles inland were geological excursions of great interest. Here he had the first sight of the guanaco of the Patagonian plains. The weather was fine, and at night-fall, to the golden light of sunset succeeded the fitful glow, over land and water, of the bonfires built by the sailors on the beach. Returning to the ship after dark, the various parties assembled in the wardroom, to talk over the events of the day and lay out plans for the morrow. These are the brightest hours in such a voyage, when the novelty of the locality gives a zest to every walk or row, and all are full of interest in a new and exciting life. One is more tolerant even of monotonous natural features in a country so isolated, so withdrawn from human life and occupation. The very barrenness seems in harmony with the intense solitude.

The Hassler left her anchorage on this desolate shore on an evening of singular beauty. It was difficult to tell when she was on her way, so quietly did she move through the glassy waters, over which the sun went down in burnished gold, leaving the sky without a cloud. The light of the beach fires followed her till they too faded, and only the phosphorescence of the sea attended her into the

night. Rough and stormy weather followed this fair start, and only two more dredgings were possible before reaching the Strait of Magellan. One was off the Gulf of St. George, where gigantic star-fishes seemed to have their home. One of them, a superb basket-fish, was not less than a foot and a half in diameter; and another, like a huge sunflower of reddish purple tint, with straight arms, thirty-seven in number, radiating from the disk, was of about the same size. Many beautiful little sea-urchins came up in the same dredging. About fifty miles north of Cape Virgens, in tolerably calm weather, another haul was tried, and this time the dredge returned literally solid with Ophiurans.

On Wednesday, March 13th, on a beautifully clear morning, like the best October weather in New England, the Hassler rounded Cape Virgens and entered the Strait of Magellan. The tide was just on the flood, and all the conditions favorable for her run to her first anchorage in the Strait at Possession Bay. Here the working force divided, to form two shore parties, one of which, under Agassiz's direction, the reader may follow. The land above the first shore bluff at Possession Bay rises to a height of some four hundred

feet above the sea-level, in a succession of regular horizontal terraces, of which Agassiz counted eight. On these terraces, all of which are built, like the shore-bluffs, of tertiary deposits, were two curious remnants of a past state of things. The first was a salt-pool lying in a depression on the second terrace, some one hundred and fifty feet above the sea. This pool contained living marine shells, identical with those now found along the shore. Among them were Fusus, Mytilus, Buccinum, Fissurella, Patella, and Voluta, all found in the same numeric relations as those in which they now exist upon the beach below. This pool is altogether too high to be reached by any tidal influence, and undoubtedly indicates an old sea-level, and a comparatively recent upheaval of the shore. The second was a genuine moraine, corresponding in every respect to those which occur all over the northern hemisphere. Agassiz came upon it in ascending to the third terrace above the salt-pool and a little farther inland. It had all the character of a terminal moraine in contact with an actual glacier. It was composed of heterogeneous materials, — large and small pebbles and boulders impacted together in a paste of clayey gravel and sand. The ice had evi-

dently advanced from the south, for the mass had been pushed steeply up on the southern side, and retained so sharp an inclination on that face that but little vegetation had accumulated upon it. The northern side, on the contrary, was covered with soil and overgrown; it sloped gently off, — pebbles and larger stones being scattered beyond it. The pebbles and boulders of this moraine were polished, scratched, and grooved, and bore, in short, all the usual marks of glacial action. Agassiz was naturally delighted with this discovery. It was a new link in the chain of evidence, showing that the drift phenomena are connected at the south as well as at the north with the action of ice, and that the frozen Arctic and Antarctic fields are but remnants of a sheet of ice, which has retreated from the temperate zones of both hemispheres to the polar regions. The party pushed on beyond the moraine to a hill of considerable height, which gave a fine view of the country toward Mount Aymon and the so-called Asses' Ears. They brought back a variety of game, but their most interesting scientific acquisitions were boulders from the moraine scored with glacial characters, and shells from the salt-pool.

Still accompanied by beautiful weather, the Hassler anchored at Elizabeth Island and at San Magdalena. Here Agassiz had an opportunity of examining the haunts and rookeries of the penguins and cormorants, and obtaining fine specimens of both. As the breeding places and the modes of life of these animals have been described by other travelers, there is nothing new to add from his impressions, until the vessel anchored, on the 16th March, before Sandy Point, the only permanent settlement in the Strait.

Here there was a pause of several days, which gave Agassiz an opportunity to draw the seine with large results for his marine collections. By the courtesy of the Governor, he had also an opportunity of making an excursion along the road leading to the coal-mines. The wooded cliffs, as one ascends the hills toward the mines, are often bold and picturesque, and Agassiz found that portions of them were completely built of fossil shells. There is an oyster-bank, some one hundred feet high, overhanging the road in massive ledges that consist wholly of oyster-valves, with only earth enough to bind them together. He was inclined, from the character of the shells, to believe that the coal must be cretaceous rather than tertiary.

On Tuesday, the 19th March, the Hassler left Sandy Point. The weather was beautiful, — a mellow autumn day with a reminiscence of summer in its genial warmth. The cleft summit of Sarmiento was clear against the sky, and the snow-fields, swept over by alternate light and shadow, seemed full of soft undulations. The evening anchorage was in the Bay of Port Famine, a name which marks the site of Sarmiento's ill-fated colony, and recalls the story of the men who watched and waited there for the help that never came. The stay here was short, and Agassiz spent the time almost wholly in studying the singularly regular, but completely upturned strata which line the beach, with edges so worn down as to be almost completely even with each other.

For many days after this, the Hassler pursued her course, past a seemingly endless panorama of mountains and forests rising into the pale regions of snow and ice, where lay glaciers in which every rift and crevasse, as well as the many cascades flowing down to join the waters beneath, could be counted as she steamed by them. Every night she anchored in the sheltered harbors formed by the inlets and fiords which break the base of the

rocky walls, and often lead into narrower ocean defiles penetrating, one knows not whither, into the deeper heart of these great mountain masses.

These were weeks of exquisite delight to Agassiz. The vessel often skirted the shore so closely that its geology could be studied from the deck. The rounded shoulders of the mountains, in marked contrast to their peaked and jagged crests, the general character of the snow-fields and glaciers, not crowded into narrow valleys as in Switzerland, but spread out on the open slopes of the loftier ranges, or, dome like, capping their summits, — all this afforded data for comparison with his past experience, and with the knowledge he had accumulated upon like phenomena in other regions. Here, as in the Alps, the abrupt line, where the rounded and worn surfaces of the mountains (moutonnées, as the Swiss say) yield to their sharply cut, jagged crests, showed him the ancient and highest line reached by the glacial action. The long, serrated edge of Mount Tarn, for instance, is like a gigantic saw, while the lower shoulders of the mass are hummocked into a succession of rounded hills. In like manner the two beautiful valleys, separated by a bold bluff

called Bachelor's Peak, are symmetrically rounded on their slopes, while their summits are jagged and rough.

On one occasion the Hassler encountered one of those sudden and startling flaws of wind common to the Strait. The breeze, which had been strong all day, increased with sudden fury just as the vessel was passing through a rather narrow channel, which gave the wind the additional force of compression. In an inconceivably short time, the channel was lashed into a white foam; the roar of wind and water was so great you could not hear yourself speak, though the hoarse shout of command and the answering cry of the sailors rose above the storm. To add to the confusion, a loose sail slatted as if it would tear itself in pieces, with that sharp, angry, rending sound which only a broad spread of loose canvas can make. It became impossible to hold the vessel against the amazing power of the blast, and the Captain turned her round with the intention of putting her into Borja Bay, not far from which, by good fortune, she chanced to be. As she came broadside to the wind in turning, it seemed as if she must be blown over, so violently did she careen. Once safely round, she flew before the

wind, which now became her ally instead of her enemy, and by its aid she was soon abreast of Borja Bay. Never was there a more sudden transition from chaos to peace than that which ensued as she turned in from the tumult in the main channel to the quiet waters of the bay. The Hassler almost filled the tiny harbor shut in between mountains. She lay there safe and sheltered in breathless calm, while the storm raged and howled outside. These frequent, almost land-locked coves, are the safety of navigators in these straits; but after this day's experience, it was easy to understand how sailing vessels may be kept waiting for months between two such harbors, struggling vainly to make a few miles and constantly driven back by sudden squalls.

In this exquisite mountain-locked harbor, the vessel was weather-bound for a couple of days. Count Pourtalès availed himself of this opportunity to ascend one of the summits. Up to a height of fifteen hundred feet, the rock was characterized by the smoothed, rounded surfaces which Agassiz had observed along his whole route in the Strait. Above that height all was broken and rugged, the line of separation being as defined as on any valley wall in Switzerland. It was again im-

possible to decide, on such short observation, whether these effects were due to local glacial action, or whether they belonged to an earlier general ice-period. But Agassiz became satisfied, as he advanced, that the two sets of phenomena existed together, as in the northern hemisphere. The general aspect of the opposite walls of the Strait confirmed him in the idea that the sheet of ice in its former extension had advanced from south to north, grinding its way against and over the northern wall to the plains beyond. In short, he was convinced that, as a sheet of ice has covered the northern portion of the globe, so a sheet of ice has covered also the southern portion, advancing, in both instances, far toward the equatorial regions. His observations in Europe, in North America, and in Brazil seemed here to have their closing chapter.

With these facts in his mind, he did not fail to pause before Glacier Bay, noted for its immense glacier, which seems, as seen from the main channel, to plunge sheer down into the waters of the bay. A boat party was soon formed to accompany him to the glacier. It proved less easy of access than it looked at a distance. A broad belt of wood, growing, as Agassiz afterward found, on an accumula-

tion of old terminal moraines, spanned the lower valley from side to side. Through this wood there poured a glacial river, emptying itself into the bay. Strange to say, this glacier-washed forest, touching the ice on one side and the sea on the other, was full of flowers. The red bells of the glossy leaved Desfontainia, the lovely pink blossoms of the Phylesia, the crimson berries of the Pennetia, stood out in bright relief from a background of mossy tree-trunks and rocks. After an hour's walking, made laborious by the spongy character of the ground, — a mixture of loose soil and decaying vegetation, in which one sank knee-deep, — the gleam of the ice began to shimmer through the trees; and issuing from the wood, the party found themselves in front of a glacier wall, stretching across the whole valley and broken into deep rifts, caves, and crevasses of dark blue ice. The glacier was actually about a mile wide; but as the central portion was pressed forward in advance of the sides, the whole front was not presented at once. It formed a sharp crescent, with the curve turned outward. One of the caves in this front wall was some thirty or forty feet high, about a hundred feet deep, and two or three yards wide at the entrance. At the

further end it narrowed to a mere gallery, where the roof was pierced by a circular window, quite symmetrical in shape, through which one looked up to the blue sky and drifting clouds. There must be strange effects in this ice-cavern, when the sun is high and sends a shaft of light through its one window to illuminate the interior.

This first excursion was a mere reconnaissance. An approximate idea of the dimensions of the glacier, and some details of its structure, were obtained on a second visit the following day. The anchorage for the night was in Playa Parda Cove, one of the most beautiful of the many beautiful harbors of the Magellan Strait. It is entered by a deep, narrow slit, cut into the mountains on the northern side of the Strait, and widening at its farther end into a kind of pocket or basin, hemmed in between rocky walls bordered by forests, and overhung by snow and ice-fields. The next morning at half-past three o'clock, just as moonlight was fading before the dawn, and the mountains were touched with the coming day, the reveillé was sounded for those who were to return to Glacier Bay. This time Agassiz divided his force so that they could act independently of each other,

though under a general plan laid out by him. M. de Pourtalès and Dr. Steindachner ascended the mountain to the left of the valley, following its ridge, in the hope of reaching a position from which they could discover the source and the full length of the glacier. In this they did not succeed, though M. de Pourtalès estimated its length, as far as he could see from any one point, to be about three miles, beyond which it was lost in the higher range. It made part of a net-work of glaciers running back into a large massif of mountains, and fed by many a névé on their upper slopes. The depth as well as the length of this glacier remains somewhat problematical, and indeed all the estimates in so cursory a survey must be considered as approximations rather than positive results. The glazed surface of the ice is an impediment to any examination from the upper side. It would be impossible to spring from brink to brink of a crevasse, as is so constantly done by explorers of Alpine glaciers where the edges of the cracks are often snowy or granular. Here the edges of the crevasses are sharp and hard, and to spring across one of any size would be almost certain death. There is no hold for an Alpine stock, no grappling point for hands

or feet. Any investigation from the upper surface would, therefore, require special apparatus, and much more time than Agassiz and his party could give. Neither was an approach from the side very easy. The glacier arches so much in the centre, and slopes away so steeply, that when one is in the lateral depression between it and the mountain, one faces an almost perpendicular wall of ice, which blocks the vision completely. M. de Pourtalès measured one of the crevasses in this wall, and found that it had a depth of some seventy feet. Judging from the remarkable convexity of the glacier, it can hardly be less in the centre than two or three times its thickness on the edges, — something over two hundred feet, therefore. Probably none of these glaciers of the Strait of Magellan are as thick as those of Switzerland, though they are often much broader. The mountains are not so high, the valleys not so deep, as in the Alps; the ice is consequently not packed into such confined troughs. By some of the party an attempt was made to ascertain the rate of movement, signals having been adjusted the day before for its measurement. During the middle of the day, it advanced at the rate of ten inches and a fraction

in five hours. One such isolated observation is of course of little comparative value. For himself, Agassiz reserved the study of the bay, the ancient bed of the glacier in its former extension. He spent the day in cruising about the bay in the steam-launch, landing at every point he wished to investigate. His first care was to examine minutely the valley walls over which the glacier must once have moved. Every characteristic feature, known in the Alps as the work of the glaciers, was not only easily recognizable here, but as perfectly preserved as anywhere in Switzerland. The rounded knolls to which De Saussure first gave the name of *roches moutonnées* were smoothed, polished, scratched, and grooved in the direction of the ice movement, the marks running mostly from south to north, or nearly so. The general trend of the scratches and furrows showed them to have been continuous from one knoll to another. The furrows were of various dimensions, sometimes shallow and several inches broad, sometimes narrow with more defined limits, gradually passing into mere lines on a very smoothly-polished surface. Even the curious notches scooped out of the even surfaces, and technically called "coups de gouge," were not

wanting. In some places the seams of harder rock stood out for a quarter of an inch or so above adjoining decomposed surfaces; in such instances the dike alone retained the glacial marks, which had been worn away from the softer rock.

The old moraines were numerous and admirably well preserved. Agassiz examined with especial care one colossal lateral moraine, standing about two miles below the present terminus of the ice and five hundred feet above the sea-level. It consisted of the same rocks as those found on the present terminal moraine, part of them being rounded and worn, while large, angular boulders rested above the smaller materials. This moraine forms a dam across a trough in the valley wall, and holds back the waters of a beautiful lake, about a thousand feet in length and five hundred in width, shutting it in just as the Lake of Méril in Switzerland is held in its basin by the glacier of Aletsch. There are erratics some two or three hundred feet above this great moraine, showing that the glacier must have been more than five hundred feet thick when it left this accumulation of loose materials at such a height. It then united, however, with a large glacier more to the

west. Its greatest thickness, as an independent glacier, is no doubt marked, not by the boulders lying higher up, but by the large moraine which shuts in the lake. The direct connection of this moraine with the glacier in its former extension is still further shown by two other moraines, on lower levels and less perfect, but having the same relation to the present terminus of the ice. The lower of these is only one hundred and fifty feet above the actual level of the glacier. These three moraines occur on the western slope of the bay. The eastern slope is more broken, and while the rounded knolls are quite as distinct and characteristic, the erratics are more loosely scattered over the surface. In mineralogical character they agree with those on the western wall of the bay. Upon the summits of some small islands at the entrance of the bay, there are also some remnants of terminal moraines, formed by the glacier when it reached the main channel; that is, when it was some three miles longer than now.

The more recent oscillations, marking the advance and retreat of the glacier within certain limits, are shown by the successive moraines heaped up in advance of the present terminal wall. The central motion here, as in

all the Swiss glaciers, is greater than the lateral, the ice being pushed forward in the middle faster than on the sides. But there would seem to be more than one axis of progression in this broad mass of ice; for though the centre is pushed out beyond the rest, the terminal wall does not present one uniform curve, but forms a number of more or less projecting angles or folds. A few feet in front of this wall is a ridge of loose materials, stones, pebbles, and boulders, repeating exactly the outline of the ice where it now stands; a few feet in advance of this, again, is another ridge precisely like it; still a few feet beyond, another; and so on, for four or five concentric zigzag crescent-shaped moraines, followed by two others more or less marked, till they fade into the larger morainic mass, upon which stands the belt of wood dividing the present glacier from the bay. Agassiz counted eight distinct moraines between the glacier and the belt of wood, and four concentric moraines in the wood itself. It is plain that the glacier has ploughed into the forest within some not very remote period, for the trees along its margin are loosened and half uprooted, though not yet altogether decayed. In the presence of the glacier

one ceases to wonder at the effects produced by so powerful an agent. This sheet of ice, even in its present reduced extent, is about a mile in width, several miles in length, and at least two hundred feet in depth. Moving forward as it does ceaselessly, and armed below with a gigantic file, consisting of stones, pebbles, and gravel, firmly set in the ice, who can wonder that it should grind, furrow, round, and polish the surfaces over which it slowly drags its huge weight. At once destroyer and fertilizer, it uproots and blights hundreds of trees in its progress, yet feeds a forest at its feet with countless streams; it grinds the rocks to powder in its merciless mill, and then sends them down, a fructifying soil, to the wooded shore below.

Agassiz would gladly have stayed longer in the neighborhood of Glacier Bay, and have made it the central point of a more detailed examination of the glacial phenomena in the Strait. But the southern winter was opening, and already gave signs of its approach. At dawn on the 26th of March, therefore, the Hassler left her beautiful anchorage in Playa Parda Cove, six large glaciers being in sight from her deck as she came out. The scenery during the morning had a new scientific in-

terest for Agassiz, because the vessel kept along the northern side of the Strait, while the course hitherto had been nearer the southern shore. He could thus better compare the differences between the two walls of the Strait. The fact that the northern wall is more evenly worn, more rounded than the southern, had a special significance for him, as corresponding with like facts in Switzerland, and showing that the ice-sheet had advanced across the Strait with greater force in its ascending than in its descending path. The north side being the strike side, the ice would have pushed against it with greater force. Such a difference between the two sides of any hollow or depression in the direct path of the ice is well known in Switzerland.

Later in the day, a pause was made in Chorocua Bay, where Captain Mayne's chart makes mention of a glacier descending into the water. There is, indeed, a large glacier on its western side, but so inaccessible, that any examination of it would have required days rather than hours. No one, however, regretted the afternoon spent here, for the bay was singularly beautiful. On either side, deep gorges, bordered by richly-wooded cliffs and overhung by ice and snow-fields, were cut into

the mountains. Where these channels might lead, into what dim recesses of ocean and mountain, could only be conjectured. The bay, with all its inlets and fiords, was still as a church. Voices and laughter seemed an intrusion, and a louder shout came back in echoes from far-off hidden retreats. Only the swift steamer-ducks, as they shot across, broke the glassy surface of the water with their arrow-like wake. From this point the Hassler crossed to Sholl Bay, and anchored at the entrance of Smythe's Channel. As sunset faded over the snow mountains opposite her anchorage, their white reflection lay like marble in the water.

CHAPTER XXIV.

1872 : ÆT. 65.

Picnic in Sholl Bay. — Fuegians. — Smythe's Channel. — Comparison of Glacial Features with those of the Strait of Magellan. — Ancud. — Port of San Pedro. — Bay of Concepcion. — Three Weeks in Talcahuana. — Collections. — Geology. — Land Journey to Santiago. — Scenes along the Road. — Report on Glacial Features to Mr. Peirce. — Arrival at Santiago. — Election as Foreign Associate of the Institute of France. — Valparaiso. — The Galapagos. — Geological and Zoological Features. — Arrival at San Francisco.

THE next day forces were divided. The vessel put out into the Strait again for sounding and dredging, while Agassiz, with a smaller party, landed in Sholl Bay. Here, after having made a fire and pitched a tent in which to deposit wraps, provisions etc., the company dispersed in various directions along the shore, geologizing, botanizing, and collecting. Agassiz was especially engaged in studying the structure of the beach itself. He found that the ridge of the beach was formed by a glacial moraine, while accumulations of boulders, banked up in morainic ridges, concentric with

one another and with the beach moraine, extended far out from the shore like partly sunken reefs. The pebbles and boulders of these ridges were not local, or, at least, only partially so; they had the same geological character as those of the drift material throughout the Strait.

The day was favorable for work, and there was little to remind one of approaching winter. A creek of fresh water, that ran out upon one part of the beach, led up to a romantic brook, rushing down through a gorge bordered by moss-grown trees and carpeted by ferns and lichens in all its nooks and corners. This brook took its rise in a small lake lying some half a mile behind the beach. The collections made along the shore in this excursion were large and various: star-fish, volutas, sea-urchins, sea-anemones, medusae, doris; many small fishes, also, from the tide-pools, beside a number drawn in the seine.

Later in the day, when the party had assembled around the beach fire for rest and refreshment, before returning to the vessel, their lunch was interrupted by strange and unexpected guests. A boat rounded the point of the beach, and, as it came nearer, proved to be full of Fuegian natives, men, women, chil-

dren, and dogs, their invariable companions. The men alone landed, some six or seven in number, and came toward the tent. Nothing could be more coarse and repulsive than their appearance, in which the brutality of the savage was in no way redeemed by physical strength or manliness. They were almost naked, for the short, loose skins tied around the neck, and hanging from the shoulders, over the back, partly to the waist, could hardly be called clothing. With swollen bodies, thin limbs, and stooping forms; with a childish, yet cunning, leer on their faces, they crouched over the fire, spreading their hands toward its genial warmth, and all shrieking at once, "Tabac! tabac!" and "Galleta!" — biscuit. Tobacco there was none; but the remains of the lunch, such as it was, — hard bread and pork, — was distributed among them, and they greedily devoured it. Then the one who, judging from a certain deference paid him by the others, might be the chief, or leader, seated himself on a stone and sang in a singular kind of monotonous, chanting tone. The words, as interpreted by the gestures and expressions, seemed to be an improvisation concerning the strangers they had found upon the beach, and were

evidently addressed to them. There was something curious in the character of this Fuegian song. Rather recitative than singing, the measure had, nevertheless, certain divisions or pauses, as if to mark a kind of rhythm. It was brought to a close at regularly recurring intervals, and ended always in the same way, and on the same note, with a rising inflection of the voice. When the song was finished, a certain surprise and expectancy in the listeners kept them silent. This seemed to trouble the singer, who looked round with a comical air of inquiring disappointment. Thus reminded, the audience were quick to applaud, and then he laughed with pleasure, imitated the clapping of the hands in an awkward way, and nothing loth, began to sing again.

The recall gun from the Hassler brought this strange scene to a close, and the party hastened down to the beach, closely followed by their guests, who still clamorously demanded tobacco. Meanwhile the women had brought the boat close to that of the Hassler at the landing. They all began to laugh, talk, and gesticulate, and seemed a noisy crew, chattering unceasingly, with amazing rapidity, and all together. Their boat, with the babies and dogs to add to the tumult, was a perfect

babel of voices. They put off at once, keeping as close as they could to the Hassler boat, and reaching the vessel almost at the same time. They were not allowed to come on board, but tobacco and biscuit, as well as bright calico and beads for the women, were thrown down to them. They scrambled and snatched fiercely, like wild animals, for whatever they could catch. They had some idea of barter, for when they found they had received all that they were likely to get gratuitously, they held up bows and arrows, wicker baskets, birds, and the large sea-urchins, which are an article of food with them. Even after the steamer had started, they still clung to the side, praying, shrieking, screaming, for more "tabac." When they found it a hopeless chase, they dropped off, and began again the same chanting recitative, waving their hands in farewell.

Always interested in the comparative study of the races, Agassiz regretted that he had no other opportunity of observing the natives of this region and comparing them with the Indians he had seen elsewhere, in Brazil and in the United States. It is true that he and his companions, when on shore, frequently came upon their deserted camps, or single empty

huts; and their canoes followed the Hassler several times, but never when it was convenient to stop and let them come up with the vessel. This particular set were not in a canoe, but in a large boat of English build. Probably they had stolen it, or had found it, perhaps, stranded on the shore. They are usually, however, in canoes of their own making. One can only wonder that people ingenious enough to construct canoes so well modeled and so neatly and strongly put together, should have invented nothing better in the way of a house than a hut built of flexible branches, compared with which a wigwam is an elaborate dwelling. These huts are hood-like in shape, and too low for any posture but that of squatting or lying down. In front is always a scorched spot on the ground, where their handful of fire has smouldered; and at one side, a large heap of empty shells, showing that they had occupied this place until they had exhausted the supply of mussels, on which they chiefly live. When this is the case, they move to some other spot, gather a few branches, reconstruct their frail shelter, and continue the same life. Untaught by their necessities, they wander thus, naked and homeless, in snow, mist, and rain, as they have done

for ages, asking of the land only a strip of beach and a handful of fire; and of the ocean, shell-fish enough to save them from starvation.

The Hassler had now fairly entered upon Smythe's Channel, and was anchored at evening (March 27th) in Otway Bay, a lake-like harbor, broken by islands. Mount Burney, a noble, snow-covered mountain, corresponding to Mount Sarmiento in grandeur of outline, was in full view, but was partially veiled in mist. On the following day, however, the weather was perfect for the sail past Sarmiento Range and Snowy Glacier, which were in sight all day. Blue could not be more deep and pure, nor white more spotless, than their ice and snow-fields. Toward the latter part of the day, an immense expanse of snow opened out a little beyond Snowy Range. It was covered with the most curious snow hummocks, forming high cones over the whole surface, their shadows slanting over the glittering snow in the afternoon sunshine. They were most fantastic in shape, and some fifty or sixty in number. At first sight, they resembled heaped-up mounds or pyramids of snow; but as the vessel approached, one group of them, so combined as to simulate a

fortification, showed a face of rock where the snow had been blown away, and it seemed therefore probable that all were alike, — snow-covered pinnacles of rock.

The evening anchorage on the 28th was in Mayne's Harbor, a pretty inlet of Owen's Island. Here the vessel was detained for twenty-four hours by the breaking of the reversing rod. The engineers repaired it to the best of their ability, with such apparatus as they had, but it was a source of anxiety till a port was reached where a new one could be supplied. The detention, had it not been for such a cause, was welcome to the scientific party. Agassiz found the rounded and moutonnées surfaces and the general modeling of the outlines of ice no less marked here than in the Strait; and in a ramble over the hills above the anchorage, M. de Pourtalès came upon very distinct glacial scorings and furrows on dikes and ledges of greenstone and syenite. They were perfectly regular, and could be connected by their trend from ledge to ledge, across intervening spaces of softer decomposed rock, from which all such surface markings had disappeared.

The country above Mayne's Harbor was pretty, though somewhat barren. Beyond the

narrow belt of woods bordering the shore, the walking was over soggy hummocks, with little growth upon them except moss, lichens, and coarse marsh grass. These were succeeded by ridges of crumbling rock, between which were numerous small lakes. The land seemed very barren of life. Even the shores of the ponds were hardly inhabited. No song of bird or buzz of insect broke the stillness. Rock after rock was turned over in the vain expectation of finding living things on the damp under side at least; and the cushions of moss were broken up in the same fruitless chase. All was barren and lifeless. Not so on the shore, where the collecting went on rapidly. Dredge and nets were at work all the morning, and abundant collections were made also from the little nooks and inlets of the beach. Agassiz found two new jelly-fishes, and christened them at once as the locality suggested, one for Captain Mayne, the other for Professor Owen. Near the shore, birds also seemed more abundant. A pair of kelp-geese and a steamer duck were brought in, and one of the officers reported humming-birds flitting across the brook from which the Hassler's tanks were filled.

Early on the morning of the 30th, while

mountains and snow-fields, woodland and water, still lay between moonlight and sunrise, the Hassler started for Tarn Bay. It was a beautiful Easter Sunday, with very little wind, and a soft sky, broken by few clouds. But such beginnings are too apt to be delusive in this region of wet and fog, and a heavy rain, with thick mist, came up in the afternoon. That night, for the first time, the Hassler missed her anchorage, and lay off the shore near an island, which afforded some protection from the wind. A forlorn hope was detailed to the shore, where a large fire was kept burning all night, that the vessel might not lose her bearings and drift away. In the morning all was right again, and she kept on her course to Rowlet Narrows.

This passage is formed by a deep gorge, cleft between lofty walls over which many a waterfall foams from reservoirs of snow above. Agassiz observed two old glacier beds on the western side of the pass — two shallow depressions, lying arid and scored between swelling wooded ridges. He had not met in all the journey a better locality for the study of glacial effects than here. The sides of the channel show these traces throughout their whole length. In this same neighborhood, as a con-

spicuous foreground on the shore of Indian Reach, to the south of Lackawanna Cove, is a large moraine resembling the "horse-backs," in the State of Maine, New England. The top was as level as a railroad embankment. The anchorage for the night was in Eden Harbor, and for that evening, at least, it was lovely enough to deserve its name. The whole expanse of its land-locked waters, held between mountains and broken by islands, was rosy and purple in the setting sun. The gates of the garden were closed, however, not by a flaming sword, but by an impenetrable forest, along the edge of which a scanty rim of beach hardly afforded landing or foothold. The collections here, therefore, were small; but a good haul was made with the trawl net, which gathered half-a-dozen species of echinoderms, some small fishes, and a number of shells. Fog detained the vessel in Eden Harbor till a late hour in the morning, but the afternoon was favorable for the passage through the English Narrows, the most contracted part of Smythe's Channel. It is, indeed, a mere mountain defile, through which the water rushes with such force that, in navigating it, great care was required to keep the vessel off the rocks. Her anchorage at the close of the

day was in Connor's Cove, a miniature harbor not unlike Borja Bay in the Strait. It was a tranquil retreat. The water-birds seemed to find it so, for the steamer ducks were trailing their long wakes through the water, and a large kind of stormy petrel sailed up to the vessel, and almost put himself into the hands of the sailors, with whom he remained an unresisting prisoner.

Geologically, Agassiz found Connor's Cove of especial interest. It runs east and west, opening on the eastern side of the channel; but the knolls, that is to say, the rounded surfaces at its entrance, are furrowed across the cove, at right angles with it. In other words, the movement of the ice, always from south to north, has been with Smythe's Channel, and across the Strait of Magellan. Indeed it seemed to Agassiz that all the glacial agency in Smythe's Channel, the trend of the furrows, the worn surfaces whereon they were to be found, and the steepness of southern exposures as compared with the more rounded opposite slopes, pointed to the same conclusion.

On the third of April Agassiz left with regret this region of ocean and mountain, glacier, snow-field, and forest. The weeks he had

spent there were all too short for the work he had hoped to do. Yet, trained as he was in glacial phenomena, even so cursory an observation satisfied him that in the southern, as in the northern hemisphere, the present glaciers are but a remnant of the ancient ice-period.

After two days of open sea and head winds, the next anchorage was in Port San Pedro, a very beautiful bay opening on the north side of Corcovado Gulf, with snow mountains in full sight; the Peak of Corcovado and a wonderfully symmetrical volcanic mountain, Melimoya, white as purest marble to the summit, were clearly defined against the sky. Forests clothed the shore on every side, and the shelving beach met the wood in a bank of wild Bromelia, most brilliant in color. Not only were excellent collections made on this beach, but the shore was strewn with large accumulations of erratics. Among them was a green epidotic rock which Agassiz had traced to this spot from the Bay of San Antonio on the Patagonian coast, without ever finding it in place. Some of the larger boulders had glacial furrows and scratches upon them, and all the hills bordering the shore were rounded and moutonnée. One of the great charms for Agassiz in the scenery of all

this region, and especially in the Strait of Magellan, was a kind of home feeling that it gave him. Although the mountains rose from the ocean, instead of from the plain as in Switzerland, yet the snow-fields and the glaciers carried him back to his youth. To him, the sunset of this evening in the Port San Pedro, with the singular transparent rose color over the snow mountains, and the soft succeeding pallor, was the very reproduction of an Alpine sunset.

The next morning brought a disappointment. From this point Agassiz had hoped to continue the voyage by the inside passage between the main-land and the island of Chiloe. This was of importance to him, on account of its geological relation to Smythe's Channel and the Strait of Magellan. In the absence of any good charts of the channel, the Captain, after examining the shoals at the entrance, was forced to decide, almost as much to his own regret as to that of Agassiz, not to attempt the further passage. Keeping up the outer coast of Chiloe, therefore, the vessel anchored before Ancud on the 8th of April. It was a heavenly day. The volcanic peak of Osorno and the whole snowy Cordilleras were unveiled. The little town above the harbor,

with its outlying farms on the green and fertile hills around, seemed like the very centre of civilization to people who had been so long out of the world. It is said to rain in Ancud three hundred and sixty-five days in the year. But on this particular afternoon it was a very sunny place, and the inhabitants seemed to avail themselves of their rare privilege. Groups of Indians, who had come across the river in the morning to sell their milk in the town, were resting in picturesque groups around their empty milk-cans, the women wrapped in their long shawls, the men in their ponchos and slouched hats; the country people were driving out their double teams of strong, powerful oxen harnessed to wooden troughs filled with manure for the fields; the washerwomen were scrubbing and beating their linen along the roadside; the gardens of the poorest houses were bright with large shrubs of wild fuchsia, and, altogether, the aspect of the little place was cheerful and pretty. Agassiz had but two or three hours for a look at the geology. Even this cursory glance sufficed to show him that the drift materials, even to their special mineralogical elements, were the same as in the Magellan Strait. Here they rested, however, on volcanic soil.

Stopping at Lota for coal, but not long enough for any scientific work, the Hassler entered Concepcion Bay on the 15th April, and anchored near Talcahuana, where she was to remain some three weeks for the repair of her engine. This quaint, primitive little town is built upon one of the finest harbors on the Pacific coast. Agassiz was fortunate in finding, through the kindness of Captain Johnson, a partially furnished house, where several large vacant rooms, opening on the "patio," served admirably as scientific laboratories. Here, then, he established himself with his assistants. It was soon understood that every living thing would find a market with him, and all the idle urchins about the town flocked to the house with specimens. An unceasing traffic of birds, shells, fish, etc., went on there from morning to night, and to the various vendors were added groups of Indians coming to have their photographs taken. There were charming excursions and walks in the neighborhood, and the geology of the region was so interesting that it determined Agassiz to go by land from Talcahuana to Valparaiso, on a search after any glacial tracks that might be found in the valley lying between the Cordillera of the Andes and the

Coast Range. Meanwhile the Hassler was to go on a dredging expedition to the island of Juan Fernandez, and then proceed to Valparaiso, where Agassiz was to join her a fortnight later. Although this expedition was under the patronage of the Coast Survey, the generosity of Mr. Thayer, so constantly extended to scientific aims, had followed Agassiz on this second journey. To his kindness he owed the possibility of organizing an excursion apart from the direct object of the voyage. This change of plan and its cause is told in the following extract from his general report to Professor Peirce: —

"*April 27th.* While I was transcribing my Report, Pourtalès came in with the statement that he had noticed the first indication of an Andean glacier in the vicinity. I have visited the locality twice since. It is a magnificent polished surface, as well preserved as any I have ever seen upon old glaciated ground or under glaciers of the present day, with well-marked furrows and scratches. Think of it! a characteristic surface, indicating glacier action, in lat. 37° S., at the level of the sea! The place is only a few feet above tide level, upon the slope of a hill on

which stand the ruins of a Spanish fort, near the fishermen's huts of San Vicente, which lies between Concepcion Bay and the Bay of Aranco. Whether the polished surface is the work of a glacier descending from the Andes to the sea-shore or not, I have not yet been able to determine. I find no volcanic pebbles or boulders in this vicinity, which, after my experience in San Carlos, I should expect all along the shore, if the glaciers of the Andes had descended to the level of the ocean, in this part of the country. The erratics here have the character of those observed farther south. It is true the furrows and scratches of this polished surface run mainly from east to west; but there are some crossing the main trend, at angles ranging from 20° to 30°, and running S. E. N. W. Moreover, the magnetic variation is 18° 3′ at Talcahuano April 23d, the true meridian bearing to the right of the magnetic. I shall soon know what to make of this, as I start to-morrow for the interior, to go to Santiago and join the ship again at Valparaiso. I have hired a private carriage, to be able to stop whenever I wish so to do. I also take a small seine to fish for fresh water fishes in the many streams intervening between this place and Valparaiso. The trend

of the glacial scratches in San Vicente reminds me of a fact I have often observed in New England near the sea-shore, where the glacial furrows dip to a considerable extent eastward toward the deep ocean, while further inland their trend is more regular and due North and South. . . .

"I had almost forgotten to say that I have obtained unquestionable evidence of the cretaceous age of the coal deposits of Lota and the adjoining localities, north and south, which are generally supposed to be tertiary lignites. They are overlaid by sandstone containing Baculites! I need not adduce other evidence to satisfy geologists of the correctness of my assertion. I have myself collected a great many of these fossils, in beds resting upon coal-seams. Ever truly yours,

"LOUIS AGASSIZ."

On the 28th of April, then, Agassiz left Talcahuana, accompanied by Mrs. Agassiz, and by Dr. Steindachner, who was to assist him in making collections along the way. They were to travel post, along the diligence road, until they reached Curicu, within half a day of Santiago, where railroad travel began. It was a beautiful journey, and though the

rainy season was impending, the fair weather was uninterrupted. The way lay for the most part through an agricultural district of corn, wheat, and vineyards. In this strange land, where seasons are reversed, and autumn has changed places with spring, the work of harvest and vintage was just going on. The road was full of picturesque scenes: troops of mules might be met, a hundred at a time, laden with corn-sacks; the queer, primitive carts of the country creaked along, carrying huge wine-jars filled with the fresh new juice of the grape; the road was gay with country people in their holiday dresses; the women, who wore their bright shawls like a kind of mantle, were sometimes on foot and sometimes pillioned behind the men, who were invariably on horseback, and whose brilliant ponchos and fine riding added to the impression of life and color. Rivers and streams were frequent; and as there were no bridges, the scenes at the fords, sometimes crossed on rafts, sometimes on flat boats, worked by ropes, were exciting and picturesque. For rustic interiors along the road side, there were the huts of the working people, rough trellises of tree-trunks interwoven with branches; green as arbors while fresh, a coarse thatch when dry. There was

always a large open space in front, sheltered by the projecting thatch of the house, and furnished sometimes with a rough table and bench. Here would be the women at their work, or the children at play, or sometimes the drovers taking their lunch of tortillas and wine, while their animals munched their mid-day meal hard by. The scenery was often fine. On the third day the fertile soil, watered by many rivers, was exchanged for a sandy plain, broken by a thorny mimosa scattered over the surface. This plain lay between the Cordillera of the Andes and the Coast Range. As the road advanced farther inland, the panorama of the Cordilleras became more and more striking. In the glow of the sunset, the peaks of the abrupt, jagged walls and the volcano-like summits were defined against the sky in all their rugged beauty. There was little here to remind one of the loveliness of the Swiss Alps. With no lower green slopes, no soft pasturage grounds leading gently up to rocky heights, the Andes, at least in this part of their range, rise arid, stern, and bold from base to crest, a fortress wall unbroken by tree or shrub, or verdure of any kind, and relieved only by the rich and varied coloring of the rock.

The lodgings for the night were found in small towns along the road, Tomé, Chilian, Linarez, Talca, Curicu, and once, when there was no inn within reach, at a hospitable hacienda.

A brief sketch of the geological observations made on this excursion is found in a letter from Agassiz to Mr. Peirce. He never wrote out, as he had intended to do, a more detailed report.

Off Gautemala, *July* 29, 1872.

My dear Peirce, — . . . I have another new chapter concerning glacial phenomena, gathered during our land-journey from Talcahuana to Santiago. It is so complicated a story that I do not feel equal now to recording the details in a connected statement, but will try to give you the main facts in a few words.

There is a broad valley between the Andes and the Coast Range, the valley of Chilian, extending from the Gulf of Ancud, or Port de Mott, to Santiago and farther north. This valley is a continuation, upon somewhat higher level, of the channels which, from the Strait of Magellan to Chiloë, separate the islands from the main-land, with the sole interruption of Tres Montes. Now this great valley,

extending for more than twenty-five degrees of latitude, is a *continuous glacier bottom*, showing plainly that for its whole length the great southern ice-sheet has been retreating southward in it. I could find nowhere any indication that glaciers descending from the Andes had crossed this valley and reached the shores of the Pacific. In a few brief localities only did I notice Andean, *i. e.* volcanic, erratics upon the loose materials filling the old glacier bottom. Between Curicu and Santiago, however, facing the gorge of Tenon, I saw two distinct lateral moraines, parallel to one another, chiefly composed of volcanic boulders, resting upon the old drift, and indicating by their position the course of a large glacier that once poured down from the Andes of Tenon, and crossed the main valley, without, however, extending beyond the eastern slope of the Coast Range. These moraines are so well marked that they are known throughout the country as the cerillos of Tenon, but nobody suspects their glacial origin; even the geologists of Santiago assign a volcanic origin to them. What is difficult to describe in this history are the successive retrograde steps of the great southern ice-field that, step by step, left larger or smaller

tracts of the valley to the north of it free of ice, so that large glacial lakes could be formed, and seem, indeed, always to have existed along the retreating edge of the great southern glacier. The natural consequence is that there are everywhere stratified terraces without border barriers (since these were formed only by the ice that has vanished), resting at successively higher or lower levels, as you move north or south, upon unstratified drift of older date; the northernmost of these terraces being the oldest, while those further south belong to later steps in the waning of the ice-fields. From these data I infer that my suggestion concerning the trend of the striæ upon the polished and glaciated surface of the vicinity of Talcahuana, alluded to in the postscript of my last letter, is probably correct. . . .

At Santiago Agassiz rested a day or two. Here, as everywhere throughout the country, he met with the greatest kindness and cordiality. A public reception and dinner were urged upon him by the city, but his health obliged him to decline this and like honors elsewhere. Among the letters awaiting him here, was one which brought him a pleasant

surprise. It announced his election as Foreign Associate of the Institute of France, — "one of the eight." As the crowning honor of his scientific career, this was, of course, very gratifying to him. In writing soon after to the Emperor of Brazil, who had expressed a warm interest in his election, he says: "The distinction pleased me the more because so unexpected. Unhappily it is usually a brevet of infirmity, or at least of old age, and in my case it is to a house in ruins that the diploma is addressed. I regret it the more because I have never felt more disposed for work, and yet never so fatigued by it."

From Santiago Agassiz proceeded to Valparaiso, where he rejoined the ship's company. The events of their cruise had been less satisfactory than those of his land-journey, for, owing to the rottenness of the ropes, produced by dampness, the hauls of the dredge from the greatest depths had been lost. Several pauses for dredging in shallower waters were made with good success, nevertheless, on the way up the coast to Callao. From there the Hassler put out to sea once more, for the Galapagos, arriving before Charles Island on the 10th of June, and visiting in succession Albemarle, James, Jarvis, and Indefatigable islands.

Agassiz enjoyed extremely his cruise among these islands of such rare geological and zoological interest. Purely volcanic in character, and of very recent formation, they yet support a fauna and flora quite their own, very peculiar and characteristic. Albemarle Island was, perhaps, the most interesting of all. It is a barren mountain rising from the sea, its base and slope covered with small extinct craters. No less than fifty — some perfectly symmetrical, others irregular, as if blasted out on one side — could be counted from the deck as the vessel neared the shore. Indeed, the whole island seemed like some subterranean furnace, of which these craters were the chimneys. The anchorage was in Tagus Sound, a deep, quiet bay, less peaceful once, for its steep sides are formed by the walls of an old crater.

The next day, June 15, was spent by the whole scientific party in a ramble on shore. The landing was at the foot of a ravine. Climbing its left bank, they were led by a short walk to the edge of a large crater, which held a beautiful lake in its cup. It was, in fact, a crater within a crater, for a second one, equally symmetrical, rose outside and above it. Following the brink of this lake to

its upper end, they struck across to the head of the ravine. It terminated in a ridge, which looked down upon an immense field or sea of hardened lava, spreading over an area of several miles till it reached the ocean. This ancient bed of lava was full of the most singular and fantastic details of lava structure. It was a field of charred ruins, among which were more or less open caves or galleries, some large enough to hold a number of persons standing upright, others hardly allowing room to creep through on hands and knees. Rounded domes were common, sometimes broken, sometimes whole; now and then some great lava bubble was pierced with a window blasted out of the side, through which one could look down to the floor of a deep, underground hollow.

The whole company, some six or eight persons, lunched in one of the caves, resting on the seats formed by the ledges of lava along its sides. It had an entrance at either end, was some forty feet long, at least ten feet high in the centre, and perhaps six or eight feet wide. Probably never before had it served as a banqueting hall. Such a hollow tunnel or arch had been formed wherever the interior of a large mass of lava, once cooled,

had become heated again, and had flowed out, leaving the outside crust standing. The whole story of this lava bed is so clearly told in its blackened and extinct remains, that it needs no stretch of the imagination to recreate the scene. It is again a heaving, palpitating sheet of fire; the dead slags are aglow, and the burned-out furnaces cast up their molten, blazing contents, as of old. Now it is the home of the large red and orange-colored iguanas, of which a number were captured, both alive and dead. These islands proved, indeed, admirable collecting grounds, the more interesting from the peculiarity of their local fauna.

FROM AGASSIZ TO PROFESSOR PEIRCE.

OFF GUATEMALA, *July* 29.

. . . Our visit to the Galapagos has been full of geological and zoölogical interest. It is most impressive to see an extensive archipelago, of *most recent origin*, inhabited by creatures so different from any known in other parts of the world. Here we have a positive limit to the length of time that may have been granted for the transformation of these animals, if indeed they are in any way derived from others dwelling in different parts

of the world. The Galapagos are so recent that some of the islands are barely covered with the most scanty vegetation, itself peculiar to these islands. Some parts of their surface are entirely bare, and a great many of the craters and lava streams are so fresh, that the atmospheric agents have not yet made an impression on them. Their age does not, therefore, go back to earlier geological periods; they belong to our times, geologically speaking. Whence, then, do their inhabitants (animals as well as plants) come? If descended from some other type, belonging to any neighboring land, then it does not require such unspeakably long periods for the transformation of species as the modern advocates of transmutation claim; and the mystery of change, with such marked and characteristic differences between existing species, is only increased, and brought to a level with that of creation. If they are autochthones, from what germs did they start into existence? I think that careful observers, in view of these facts, will have to acknowledge that our science is not yet ripe for a fair discussion of the origin of organized beings. . . .

There is little to tell for the rest of the

voyage that cannot be condensed into a few words. There was a detention for despatches and for Coast Survey business at Panama, — a delay which was turned to good account in collecting, both in the Bay and on the Isthmus. At San Diego, also, admirable collections were made, and pleasant days were spent. This was the last station on the voyage of the Hassler. She reached her destination and entered the Golden Gate on the 24th of August, 1871. Agassiz was touched by his reception in San Francisco. Attentions and kindnesses were showered upon him from all sides, but his health allowed him to accept only such hospitalities as were of the most quiet and private nature. He passed a month in San Francisco, but was unable to undertake any of the well-known excursions to the Yosemite Valley or the great trees. Rest and home became every day more imperative necessities.

CHAPTER XXV.

1872–1873: ÆT. 65–66.

Return to Cambridge. — Summer School proposed. — Interest of Agassiz. — Gift of Mr. Anderson. — Prospectus of Penikese School. — Difficulties. — Opening of School. — Summer Work. — Close of School. — Last Course of Lectures at Museum. — Lecture before Board of Agriculture. — Illness. — Death. — Place of Burial.

In October, 1872, Agassiz returned to Cambridge. To arrange the collections he had brought back, to write a report of his journey and its results, to pass the next summer quietly at his Nahant laboratory, continuing his work on the Sharks and Skates, for which he had brought home new and valuable material, seemed the natural sequence of his year of travel. But he found a new scheme of education on foot; one for which he had himself given the first impulse, but which some of his younger friends had carefully considered and discussed in his absence, being confident that with his help it might be accomplished. The plan was to establish a summer school

of natural history somewhere on the coast of Massachusetts, where teachers from our schools and colleges could make their vacations serviceable, both for work and recreation, by the direct study of nature. No sooner was Agassiz once more at home than he was confronted by this scheme, and he took it up with characteristic ardor. Means there were none, nor apparatus, nor building, nor even a site for one. There was only the ideal, and to that he brought the undying fervor of his intellectual faith. The prospectus was soon sketched, and, once before the public, it awakened a strong interest. In March, when the Legislature of Massachusetts made their annual visit to the Museum of Comparative Zoölogy, Agassiz laid this new project before them as one of deep interest for science in general, and especially for schools and colleges throughout the land. He considered it also an educational branch of the Museum, having, as such, a claim on their sympathy, since it was in the line of the direct growth and continuance of the same work. Never did he plead more eloquently for the cause of education. His gift as a speaker cannot easily be described. It was born of conviction, and was as simple as it

was impassioned. It kept the freshness of youth, because the things of which he spoke never grew old to him, but moved him to the last hour of his life as forcibly as in his earlier years.

This appeal to the Legislature, spoken in the morning, chanced to be read in the evening papers of the same day by Mr. John Anderson, a rich merchant of New York. It at once enlisted his sympathy both for the work and for the man. Within the week he offered to Agassiz, as a site for the school, the island of Penikese, in Buzzard's Bay, with the buildings upon it, consisting of a furnished dwelling-house and barn. Scarcely was this gift accepted than he added to it an endowment of $50,000 for the equipment of the school. Adjectives belittle deeds like these. The bare statement says more than the most laudatory epithets.

Agassiz was no less surprised than touched at the aid thus unexpectedly offered. In his letter of acknowledgment he says: "You do not know what it is suddenly and unexpectedly to find a friend at your side, full of sympathy, and offering support to a scheme which you have been trying to carry out under difficulties and with very scanty means.

I feel grateful to you for making the road so easy, and I believe you will have the permanent gratitude of scientific men here and elsewhere, for I have the utmost confidence that this summer school will give valuable opportunities for original research, as well as for instruction." At Agassiz's suggestion the school was to bear the name of "The Anderson School of Natural History." Mr. Anderson wished to substitute the name of Agassiz for his own. This Agassiz absolutely refused to permit, saying that he was but one of many scientific men who had already offered their services to the school for the coming summer, some of whom would, no doubt, continue to work for it in the future, and all of whom would be equally indebted to Mr. Anderson. It was, therefore, most suitable that it should bear his name, and so it was agreed.

Thus the material problem was solved. Name and habitation were found; it remained only to organize the work for which so fitting a home had been provided. Mr. Anderson's gift was received toward the close of March, and, in the course of the following month, the preliminaries were concluded, and the property was transferred to the trustees of the Anderson School.

PENIKESE.

Few men would have thought it feasible to build dormitories and laboratories, and provide working apparatus for fifty pupils as well as for a large corps of teachers, between May and July. But to Agassiz no obstacles seemed insurmountable where great aims were involved, and the opening of the school was announced for the 8th of July. He left Boston on Friday, the 4th of July, for the island. At New Bedford he was met by a warning from the architect that it would be simply impossible to open the school at the appointed date. With characteristic disregard of practical difficulties, he answered that it must be possible, for postponement was out of the question. He reached the island on Saturday, the 5th, in the afternoon. The aspect was certainly discouraging. The dormitory was up, but only the frame was completed; there were no floors, nor was the roof shingled. The next day was Sunday. Agassiz called the carpenters together. He told them that the scheme was neither for money, nor for the making of money; no personal gain was involved in it. It was for the best interests of education, and for that alone. Having explained the object, and stated the emergency, he asked whether, under these cir-

cumstances, the next day was properly for rest or for work. They all answered "for work." They accordingly worked the following day from dawn till dark, and by night-fall the floors were laid. On Monday, the 7th, the partitions were put up, dividing the upper story into two large dormitories; the lower, into sufficiently convenient working-rooms. On Tuesday morning (the 8th), with the help of a few volunteers, chiefly ladies connected with the school, who had arrived a day or two in advance, the dormitories, which were still encumbered by shavings, sawdust, etc., were swept, and presently transformed into not unattractive sleeping-halls. They were divided by neat sets of furniture into equal spaces, above each of which was placed the name of the person to whom it was appropriated. When all was done, the large open rooms, with their fresh pine walls, floors, and ceilings, the rows of white beds down the sides, and the many windows looking to the sea, were pretty and inviting enough. If they somewhat resembled hospital wards, they were too airy and cheerful to suggest sickness either of body or mind.

Next, a large barn belonging to Mr. Anderson's former establishment was cleared, and a

new floor laid there also. This was hardly finished (the last nails were just driven) when the steamer, with its large company, touched the wharf. There was barely time to arrange the seats and to place a table with flowers where the guests of honor were to sit, and Agassiz himself was to stand, when all arrived. The barn was, on the whole, not a bad lecture-room on a beautiful summer day. The swallows, who had their nests without number in the rafters, flew in and out, and twittered softly overhead; and the wide doors, standing broadly open to the blue sky and the fresh fields, let in the sea-breeze, and gave a view of the little domain. Agassiz had arranged no programme of exercises, trusting to the interest of the occasion to suggest what might best be said or done. But, as he looked upon his pupils gathered there to study nature with him, by an impulse as natural as it was unpremeditated, he called upon them to join in silently asking God's blessing on their work together. The pause was broken by the first words of an address no less fervent than its unspoken prelude.[1]

Thus the day, which had been anticipated

[1] This whole scene is fitly told in Whittier's poem, *The Prayer of Agassiz.*

with so much anxiety, passed off, unclouded by any untoward accident, and at evening the guests had departed. Students and teachers, a company of some fifty or sixty persons, were left to share the island with the sea-gulls whose haunt it was.

We will not enter into the daily details of the school. It was a new phase of teaching, even for Agassiz, old as he was in the work. Most of his pupils were mature men and women, some of whom had been teachers themselves for many years. He had, therefore, trained minds to deal with, and the experience was at that time as novel as it was interesting. The novelty has worn off now. Summer schools for advanced students, and especially for teachers, have taken their place in the general system of education; and, though the Penikese school may be said to have died with its master, it lives anew in many a sea-side laboratory organized on the same plan, in summer schools of Botany and field classes of Geology. The impetus it gave was not, and cannot be, lost, since it refreshed and vitalized methods of teaching.

Beside the young men who formed his corps of teachers, among whom the resident professors were Dr. Burt G. Wilder, of Cornell Uni-

versity, and Professor Alpheus S. Packard, now of Brown University, Agassiz had with him some of his oldest friends and colleagues. Count de Pourtalès was there, superintending the dredging, for which there were special conveniences, Mr. Charles G. Galloupe having presented the school with a yacht for the express purpose. This generous gift gave Agassiz the greatest pleasure, and completed the outfit of the school as nothing else could have done. Professor Arnold Guyot, also, — Agassiz's comrade in younger years, — his companion in many an Alpine excursion, — came to the island to give a course of lectures, and remained for some time. It was their last meeting in this world, and together they lived over their days of youthful adventure. The lectures of the morning and afternoon would sometimes be followed by an informal meeting held on a little hill, which was a favorite resort at sunset. There the whole community gathered around the two old friends, to hear them talk of their glacial explorations, one recalling what the other had forgotten, till the scenes lived again for themselves, and became almost equally vivid for their listeners. The subject came up naturally, for, strange to say, this island in a

New England bay was very suggestive of glacial phenomena. Erratic materials and boulders transported from the north were scattered over its surface, and Agassiz found the illustrations for his lectures on this topic ready to his hand. Indeed, some of his finest lectures on the ice-period were given at Penikese.

Nothing could be less artificial, more free from constraint or formality, than the intercourse between him and his companions of this summer. He was at home with every member of the settlement. Ill-health did not check the readiness of his sympathy; languor did not chill the glow of his enthusiasm. All turned to him for help and inspiration. Walking over their little sovereignty together, hunting for specimens on its beaches, dredging from the boats, in the laboratory, or the lecture-room, the instruction had always the character of the freest discussion. Yet the work, although combined with out-of-door pleasures, and not without a certain holiday element, was no play. On the part of the students, the application was close and unremitting; on the part of the teachers, the instruction, though untrammeled by routine, was sustained and systematic.

Agassiz himself frequently gave two lec-

tures a day. In the morning session he would prepare his class for the work of the day; in the afternoon he would draw out their own observations by questions, and lead them, by comparison and combination of the facts they had observed, to understand the significance of their results. Every lecture from him at this time was a lesson in teaching as well as in natural history, and to many of his hearers this gave his lectures a twofold value, as bearing directly upon their own occupation. In his opening address he had said to them: "You will find the same elements of instruction all about you wherever you may be teaching. You can take your classes out, and give them the same lessons, and lead them up to the same subjects you are yourselves studying here. And this mode of teaching children is so natural, so suggestive, so true. That is the charm of teaching from Nature herself. No one can warp her to suit his own views. She brings us back to absolute truth as often as we wander."

This was the bright side of the picture. Those who stood nearest to Agassiz, however, felt that the strain not only of work, but of the anxiety and responsibility attendant upon a new and important undertaking, was peril-

ous for him. There were moments when this became apparent, and he himself felt the danger. He persevered, nevertheless, to the end of the summer, and only left Penikese when the school broke up.

In order to keep the story of this final effort unbroken, some events of great interest to Agassiz and of importance to the Museum have been omitted. In the spring the Museum had received a grant of $25,000 from the Legislature. To this was added $100,000, a birthday gift to Agassiz in behalf of the institution he so much loved. This last sum was controlled by no official body and was to be expended at his own good will and pleasure, either in collections, publications, or scientific assistance, as seemed to him best. He therefore looked forward to a year of greater ease and efficiency in scientific work than he had ever enjoyed before. On returning from Penikese, full of the new possibilities thus opened to him, he allowed himself a short rest, partly at the sea-shore, partly in the mountains, and was again at his post in the Museum in October.

His last course of lectures there was on one of his favorite topics, — the type of Radiates as connected with the physical history of the

earth, from the dawn of organic life till now. In his opening lecture he said to his class: "You must learn to look upon fossil forms as the antiquarian looks upon his coins. The remains of animals and plants have the spirit of their time impressed upon them, as strongly as the spirit of the age is impressed upon its architecture, its literature, its coinage. I want you to become so familiar with these forms, that you can read off at a glance their character and associations." In this spirit his last course was conceived. It was as far-reaching and as clear as usual, nor did his delivery evince failure of strength or of mental power. If he showed in any way the disease which was even then upon him, it was by an overtension of the nerves, which gave increased fervor to his manner. Every mental effort was, however, succeeded by great physical fatigue.

At the same time he had undertaken a series of articles in the "Atlantic Monthly," entitled, "Evolution and Permanence of Type." They were to have contained his own convictions regarding the connection between all living beings, upon which his studies had led him to conclusions so different from the philosophy of the day. Of these papers, only

one was completed. It was his last word upon science; the correction of the proof-sheets was the last act of his working life, and the article was published after his death. In it he claimed that the law of evolution, in a certain sense as true to him as to any so-called evolutionist, was a law "controlling development, and keeping types within appointed cycles of growth." He maintained that this law acts within definite limits, and never infringes upon the great types, each one of which is, in his view, a structural unit in itself. Even metamorphoses, he adds, "have all the constancy and invariability of other modes of embryonic growth, and have never been known to lead to any transition of one species into another." Of heredity he says: "The whole subject of inheritance is exceedingly intricate, working often in a seemingly capricious and fitful way. Qualities, both good and bad, are dropped as well as acquired, and the process ends sometimes in the degradation of the type, and the survival of the unfit rather than the fittest. The most trifling and fantastic tricks of inheritance are quoted in support of the transmutation theory; but little is said of the sudden apparition of powerful original qualities, which almost always rise like pure creations, and are

gone with their day and generation. The noblest gifts are exceptional, and are rarely inherited; this very fact seems to me an evidence of something more and higher than mere evolution and transmission concerned in the problem of life. In the same way the matter of natural and sexual selection is susceptible of very various interpretations. No doubt, on the whole, Nature protects her best. But it would not be difficult to bring together an array of facts as striking as those produced by the evolutionists in favor of their theory, to show that sexual selection is by no means always favorable to the elimination of the chaff, and the preservation of the wheat. A natural attraction, independent of strength or beauty, is an unquestionable element in this problem, and its action is seen among animals as well as among men. The fact that fine progeny are not infrequently the offspring of weak parents, and *vice versâ*, points, perhaps, to some innate power of redress by which the caprices of choice are counterbalanced. But there can be no doubt that types are as often endangered as protected by the so-called law of sexual selection."

"As to the influence of climate and physical conditions," he continues, "we all know

their power for evil and for good upon living beings. But there is, nevertheless, nothing more striking in the whole book of nature than the power shown by types and species to resist physical conditions. Endless evidence may be brought from the whole expanse of land and air and water, showing that identical physical conditions will do nothing toward the merging of species into one another, neither will variety of conditions do anything toward their multiplication. One thing only we know absolutely, and in this treacherous, marshy ground of hypothesis and assumption, it is pleasant to plant one's foot occasionally upon a solid fact here and there. Whatever be the means of preserving and transmitting properties, the primitive types have remained permanent and unchanged, — in the long succession of ages, amid all the appearance and disappearance of kinds, the fading away of one species and the coming in of another, — from the earliest geological periods to the present day. How these types were first introduced, how the species which have successively represented them have replaced one another, — these are the vital questions to which no answer has been given. We are as far from any satisfactory solution of this problem as

if development theories had never been discussed."

In conclusion, he sketches the plan of these articles. "I hope in future articles to show, first, that, however broken the geological record may be, there is a complete sequence in many parts of it, from which the character of the succession may be ascertained; secondly, that, since the most exquisitely delicate structures, as well as embryonic phases of growth of the most perishable nature, have been preserved from very early deposits, we have no right to infer the disappearance of types because their absence disproves some favorite theory; and, lastly, that there is no evidence of a direct descent of later from earlier species in the geological succession of animals"

This paper contained the sentence so often quoted since, "A physical fact is as sacred as a moral principle. Our own nature demands from us this double allegiance." This expressed the secret of his whole life. Every fact in nature was sacred to him, as part of an intellectual conception expressed in the history of the earth and the beings living upon it.

On the 2d of December, he was called to a meeting of the Massachusetts Board of

Agriculture at Fitchburg, where he lectured in the evening on "The structural growth of domesticated animals." Those who accompanied him, and knew the mental and physical depression which had hung about him for weeks, could not see him take his place on the platform, without anxiety. And yet, when he turned to the blackboard, and, with a single sweep of the chalk, drew the faultless outline of an egg, it seemed impossible that anything could be amiss with the hand or the brain that were so steady and so clear.

The end, nevertheless, was very near. Although he dined with friends the next day, and was present at a family festival that week, he spoke of a dimness of sight, and of feeling "strangely asleep." On the 6th he returned early from the Museum, complaining of great weariness, and from that time he never left his room. Attended in his illness by his friends, Dr. Brown-Sequard and Dr. Morrill Wyman, and surrounded by his family, the closing week of his life was undisturbed by acute suffering and full of domestic happiness. Even the voices of his brother and sisters were not wholly silent, for the wires that thrill with so many human interests brought their message of greeting and farewell across

the ocean to his bedside. The thoughts and aims for which he had lived were often on his lips, but the affections were more vivid than the intellect in these last hours. The end came very peacefully, on the 14th of December, 1873. He lies buried at Mount Auburn. The boulder that makes his monument came from the glacier of the Aar, not far from the spot where his hut once stood; and the pine-trees which are fast growing up to shelter it were sent by loving hands from his old home in Switzerland. The land of his birth and the land of his adoption are united in his grave.

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